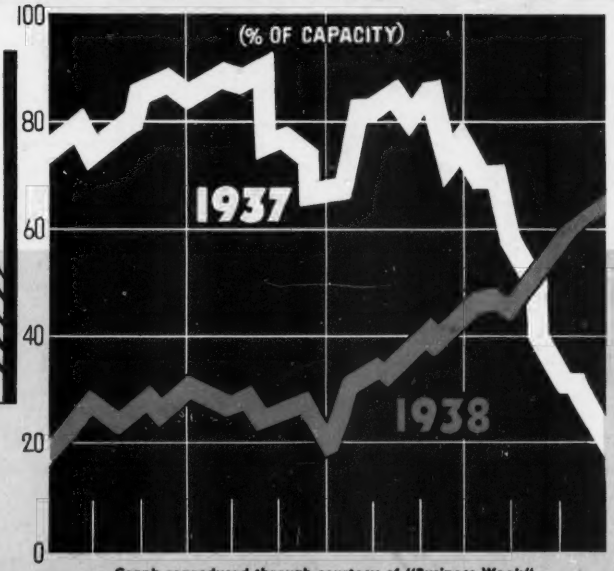
WIRE AND WIRE PRODUCTS

JANUARY 1939

THE STEEL INDUSTRY



Graph reproduced through courtesy of "Business Week"

STEP UP YOUR OPERATING EFFICIENCY THIS YEAR!

With the government spending fifty million dollars a month *more* than they are taking in—with American business traveling between the low points of depression and the high points of recovery,—the outlook for the wire mill industry during 1939 is unusually bright. Your sales departments will be selling harder and faster,—it will be your job to keep abreast with this change of pace—by producing faster, better—more efficiently.

You can't stay up there with misfit or inadequate equipment—you must have the best machinery industry can produce. Many of the alert, progressive wire mills have found the answer to their immediate problems in Vaughn Motoblocs and Motoblox. Perhaps a discussion with a Vaughn engineer will be helpful to you, too,—let's get together!

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO

VAUGHN WIRE DRAWING EQUIPMENT
COMPLETE WIRE DRAWING EQUIPMENT . . . CONTINUOUS OR SINGLE HOLE . . . FOR THE LARGEST BARS . . . FOR THE SMALLEST WIRE . . . FERROUS, NON-FERROUS MATERIALS OR THEIR ALLOYS

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

400 Miles of Steel... to light your Cigarette

THAT book of matches in your pocket would fall apart except for that inconspicuous piece of stapling wire. *It takes approximately 444 miles of that wire every day to supply the enormous demand for book matches.*

Steel is even more important in almost every act of your daily life. Many food delicacies come to you in tin plated steel cans and are cooked on a steel range; the modern plumbing and heating of your house would be impossible except for steel; your clothes, glasses, watch, shoes.... all contain vital steel parts; you probably travel in a steel automobile or train to a steel framed office building or factory, to work at a steel desk or machine.

All the comforts and conveniences of modern life, which have come to be considered necessities, have been made possible by modern refinements in steels. Such refinements in steels do not just happen .... Youngstown maintains a great laboratory and an experienced organization, always working with customers to find the steel best suited to their needs and products.

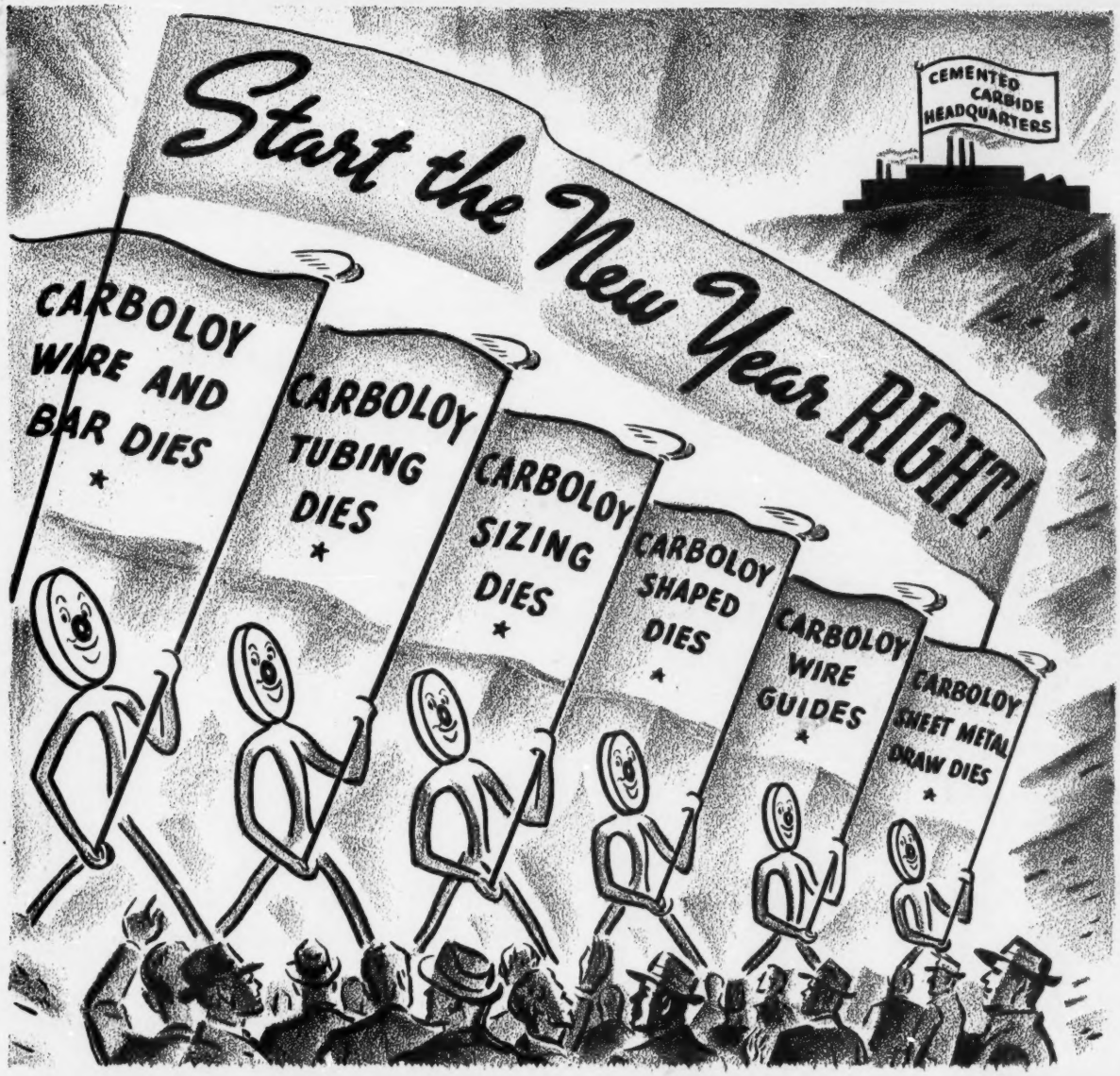
THE YOUNGSTOWN SHEET AND TUBE COMPANY

Manufacturers of Carbon and Alloy Steels

General Offices - - YOUNGSTOWN, OHIO

Sheets - Plates - Pipe and Tubular Products - Conduit - Tin Plate
Bars - Rods - Wire - Nails - Unions - Tie Plates and Spikes 25-10A

YOUNGSTOWN



Start the new year right! . . . Resolve to use dies of the highest quality—uniformly made by means of scientifically-controlled methods. . . . Use Carboloy dies for all drawing and sizing jobs. . . . Take advantage of the services of an organization of specialists devoted *exclusively* to the development, manufacture and application of cemented carbides.

In 1939 use *Carboloy* cemented carbide dies.

The Mark of CARBOLOY
REG. U. S. PAT. OFF.

CARBOLOY COMPANY, INC.

DETROIT, MICHIGAN

CHICAGO • CLEVELAND • NEWARK • PHILADELPHIA • PITTSBURGH • STAMFORD, CONN. • WORCESTER, MASS.

Authorized Distributors:

Hartley Wire Die Co., Waterbury, Conn. • Canadian General Electric Co. Ltd., Toronto, Canada

CARBOLOY REG. U.S. PAT. OFF. **DRAWING AND SIZING DIES**

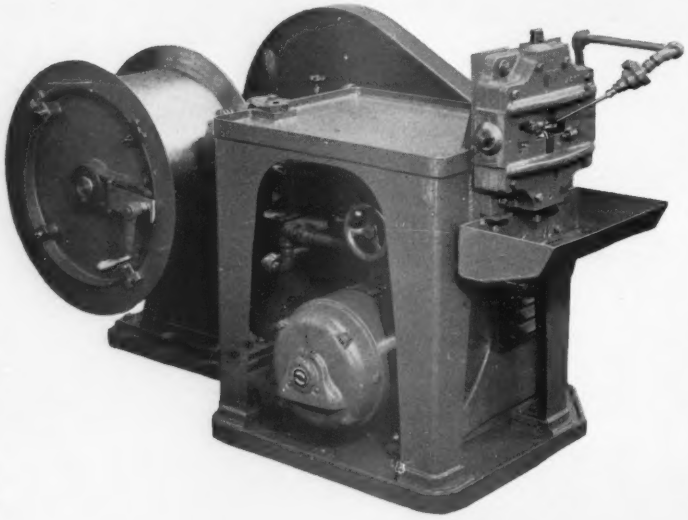
Use A "TURKS HEAD" For Forming Special Shaped Wire! For Embossing Wire!

The Wire Drawing Machine shown below provides for the use of a Turks Head in forming rectangular and special shaped wire.

"TURKS Heads" are of two types — The Universal Type and The Plain Type.

THE Universal Type is used to convert round wire to rectangular sections.

THIS type has flat faced rolls only.



THE Plain Type is used for forming special shapes of wire and also for embossing designs on Wire.

THIS type may have rolls formed for special shapes or rolls with designs engraved on them.

The take-up drum which pulls the wire through the Turks Head is of the tapered shedding type with demountable outer flange, and is placed horizontally to facilitate removal of the coil. The unit is provided with a pump and coolant for the Turks Head rolls. The drive is by means of a motor through a variable speed device. A handwheel is convenient to the operator for varying the speeds while the machine is in operation.

The "Turks Head" combines the functions of a wire drawing machine for pulling and for bundling the wire, but instead of the conventional type dies through which the wire is usually drawn, utilizes a system of rolls.

We Would Be Glad To Discuss Any Special Requirements With You.

STANDARD MACHINERY CO., Providence, R. I.

Put your Wire Problems up to Pittsburgh

Spring Wire
Box Binding Wire
Stapling Wire
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Cold Heading Wire
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Link Wire
Pot, Salt and
Lead Annealed Wire
Bale Wire
Core Wire
Spark Plug Wire
Fine Wire
Weaving Wire
Tinned Wire
Flat Wire
Galvanized Wires
Stainless Steel Wires

MORE than 35 years experience in making steel wire enable us to offer an expert service to manufacturers using wire in their products. We've been helpful to many of our customers in solving troublesome wire working difficulties, and have been most successful in developing cost saving finishes and physical properties. Don't hesitate to consult us—we welcome inquiries.

PITTSBURGH STEEL CO.
PITTSBURGH, PENNSYLVANIA

New York Cleveland Detroit Chicago St Louis
Memphis Houston Los Angeles

Pittsburgh Wires *for Every Purpose*

•GOING TO PRESS-MARCH 1st, 1939•

THE 1939 EDITION

of the

WIRE

& WIRE PRODUCTS'

Buyers Guide

and Year Book

of the

WIRE ASSOCIATION

The only reference book available listing all components of the wire industry, completely indexed.

Invaluable to purchasers of rod, strip, bare and covered wire and cable, cold drawn bars and cold headed products.

Gives sources of machinery, materials and equipment for manufacturers of rod, strip, wire and wire products.

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WRITE AT ONCE FOR FULL DETAILS

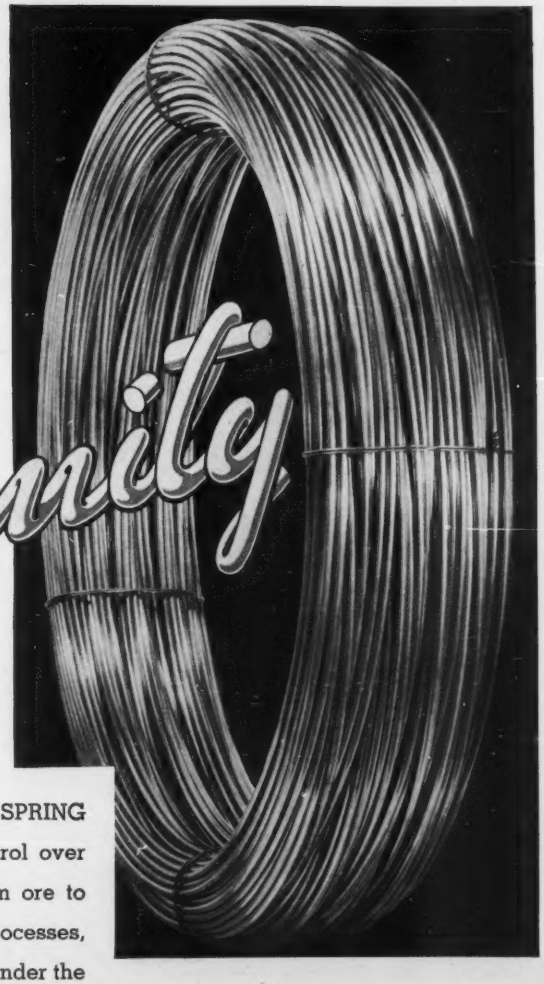
TO

WIRE & WIRE PRODUCTS

17 East 42nd Street — New York, N. Y.

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

Pittsburgh
SPRING WIRE
means
FIRST, LAST AND ALWAYS
Uniformity



The uniformity that is characteristic of PITTSBURGH SPRING WIRE is possible only because of the complete control over its manufacture. Every coil and every shipment, from ore to finished wire is made in the same plant, by the same processes, with the same equipment, by the same craftsmen and under the supervision of the same organization of wire specialists. All materials constituting the open hearth charge and all ladle additions are carefully weighed according to their predetermined analyses and characteristics. Every order goes through specific processes to insure its delivery with the properties required for your particular fabrication. Spring wire so made can be offered with confidence and used with unvarying success. Your inquiries are invited.

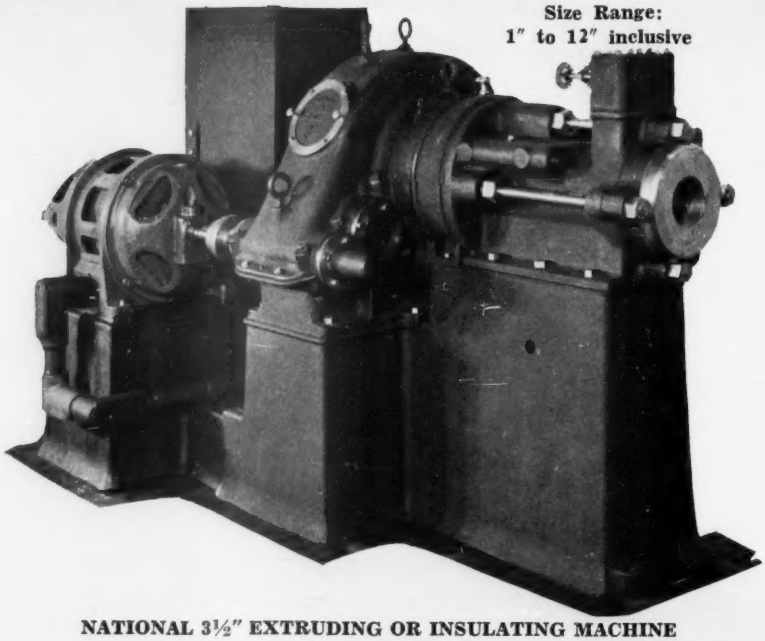
Uniform STRUCTURE
Uniform SURFACE
Uniform TEMPER
Uniform GAUGE
Uniform CAST

PITTSBURGH STEEL COMPANY
1641 GRANT BUILDING · PITTSBURGH, PA.

Pittsburgh WIRE
A COMPLETE LINE FOR ALL FABRICATING NEEDS

NATIONAL
Insulators

are fast becoming Standard Equipment for



NATIONAL 3½" EXTRUDING OR INSULATING MACHINE

THE RUBBER AND INSULATED WIRE INDUSTRY

TYPES FOR TUBING, STRAINING, AND INSULATING

Many leading manufacturers have specified NATIONAL extruders throughout for their requirements.

●

MODERN MECHANICAL REFINEMENTS ASSURE:

1. Ease and economy of operation.
2. Low maintenance.
3. Highest production yields.
4. Low temperature stock delivery.
5. Protection of stock quality.

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Banner Division, COLUMBIANA, OHIO
Eastern Division, CLIFTON, N. J.
David Bridge & Company, Ltd., Manchester, England
The Bawden Machine Company, Ltd., Toronto, Canada

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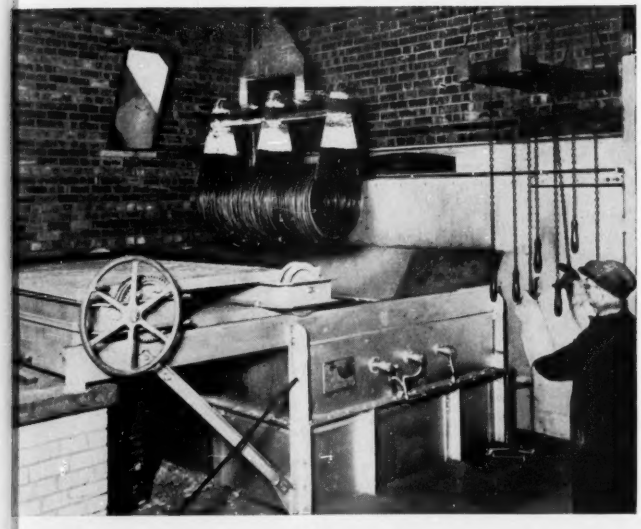
ajax HULTGREN

ELECTRIC SALT BATH FURNACE

ALL the advantages of salt bath heat treating - and NONE of the disavantages!

Annealing steel wire in coils—total heating cycle fifteen minutes compared with four hours previously required.



AN ELECTRIC FURNACE WITHOUT HEATING ELEMENTS!

Heat is generated directly in the bath by an entirely new arrangement of immersed electrodes. Electromagnetic forces provide an automatic stirring action throughout the entire bath. Previously attempts to use immersed electrodes in salt baths did not provide this electromagnetic stirring action. This vital accomplishment has made liquid heat treating operations successful where previous electrode furnace designs presented difficulties. Over one hundred installations made during the past two years attest to this fact.

OUTSTANDING ADVANTAGES

- The salt bath "controls the atmosphere" around the work by the simple process of eliminating all atmosphere. Decarburization, oxidation, and scaling, are automatically eliminated.
- Heating rate six to twenty times faster than with any other type furnace. Rapid heating and uniform temperature throughout the bath holds grain growth and distortion to an absolute minimum. Greater production than in any other furnace of equal size.
- Amazingly economical to operate. Electric power costs appreciably lower than gas or oil.
- The internal heating principle coupled with the unique stirring action of the bath prevents overshooting of temperature.
- "Heating from the inside out" assures extremely long pot life. Absence of local overheating prevents excessive decomposition of salts.
- Less labor and floor space required.
- Improved working conditions — no excessive heat nor obnoxious fumes.

Lower Salt Cost - - - More Uniform Product
Longer Electrode and Pot Life

Investigate the advantages of this unique salt bath furnace for scale-free annealing ferrous and non-ferrous wire, case hardening and carburizing all steel products, tempering steel parts, annealing and hardening aluminum alloys, hardening high speed steel tools, etc. Available for the entire heat treating range—from 350 deg. F. to 2400 deg. F.

If you must have maximum uniformity in your heat treating, let us show you how the Ajax-Hultgren Salt Bath Furnace can give it to you—plus a sizeable reduction in heat treating costs.

Write for Catalog 106, just off the press.

AJAX ELECTRIC COMPANY, INC.

953 Frankford Avenue Philadelphia, Pa.

Meets Exacting Requirements

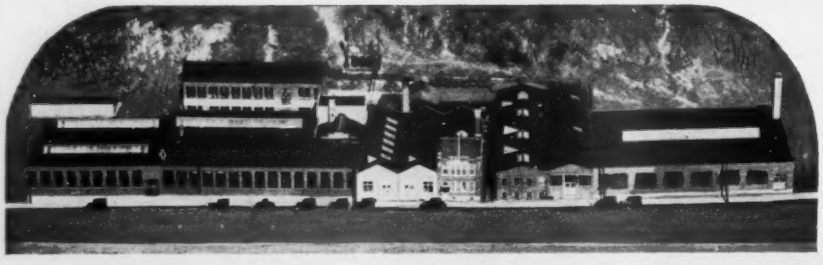
Winco

Leak-proof Enameled Wire

It is the copper we use that enables us to state without qualification that Winco Enameled Wire will not leak. We use special oxygen-free copper that draws so clean, so free from slivers, that the enameling is perfect. There's not a leak in it. Every spool of wire is mercury-tested before shipment to assure the buyer a wire as perfect as humans can make it. Write for a generous sample.

* * *

Winco Enameled wire is covered to the same dimensions as fabric-covered wire so the user need not change his equipment. It will withstand softening in varnish-dipping and baking. It costs considerably less than silk-covered wire. Write for sample.



HUDCO

Hudco Products cover a complete line of fine wires of all kinds, bare and for metal spraying. Also, brush wires of all kinds, tinsel lahns, metallic fibres for packing purposes, etc. Hudco is headquarters for supplies of this sort. Established in 1902, experience and skilled workmanship are back of every Hudco product.

HUDSON WIRE COMPANY

OSSINING, N. Y.

ESTAB. 1902 Successors ROYLE & AKIN ESTAB. 1902

953 Frankford Avenue

FAVORABLE COMMENTS

By WIRE MEN AT OUR DETROIT EXHIBIT

"YOUR WATER-COOLED FINE WIRE AETNA MACHINE IS A DECISIVE IMPROVEMENT!"

"THE WATER COOLING CERTAINLY PRESERVES THE WIRE COATING!"

"WHAT WE'VE WAITED FOR!"

"THANKS FOR A GOOD DEMONSTRATION!"

"THESE AETNA DIE HOLDERS AND DIE BOXES MAKE WIRE 'CASTING' EASY!"

"YOUR INCLUSION OF A WATER LINE STRAINER INDICATES REGARD FOR OPERATING DETAILS!"

"YOUR AETNA UNIT IS CERTAINLY FLEXIBLE!"

URDY CONSTRUCTION!"

—"A LIVE EXHIBIT!"

HOW COOL IE WIRE IS!"

"HIGHLY EDUCATIONAL!"

"AN EFFECTIVE INTRODUCTION!"

"WE LIKE THE ACCESSIBILITY OF THE AETNA VERTICAL MOTOR DRIVE!"

"THESE DRAWING BLOCKS ARE CER-TAINLY WELL GEARED FOR HIGH SPEEDS!"

"WE LIKE THE AETNA UNIT FOR ADAPTABILITY, TOO!"

"WE LIKE THAT SAFETY GUARD!"

"WELL BALANCED AND SMOOTH RUNNING!"

"THESE WATER-COOLED DIE HOLDERS SHOULD GIVE LONGER DIE LIFE!"

THE **AETNA-STANDARD** ENGINEERING COMPANY

CONSULTANTS—DESIGNERS AND BUILDERS TO THE STEEL AND NON-FERROUS INDUSTRIES

YOUNGSTOWN, · OHIO, · U. S. A.

ASSOCIATED COMPANIES

Head, Wrightson & Co. Limited, Thornaby-on-Tees, England. Aktiebolaget Arboga Mekaniska Verkstad, Arboga, Sweden.

YOU GET PAID

When Morrison FLASH Bakers Go To Work For You - - - - -

There isn't a wire mill in the country that wouldn't spend good money for these advantages. Think of being paid to get them! (1) Rod baking confined to a tank-sized unit in the cleaning house and becoming a detail in the continuous treatment of rod. (2) Six-minute average baking time per pin load with rod remaining right on the hook. (3) Uniform working quality of rod higher than that consistently maintained by any other process.

Morrison Flash Bakers will bring you these and many more advantages. Based upon the broad experience of users throughout the world, the combination of fuel economy, space saving, and working efficiency have often paid for a Flash Baker in a few months; continuing to pay you to use it for years to come.

•

Morrison Flash Bakers protected by U. S. Patent No. 1,999,513.
Other patents pending. Trade Mark registered.

•

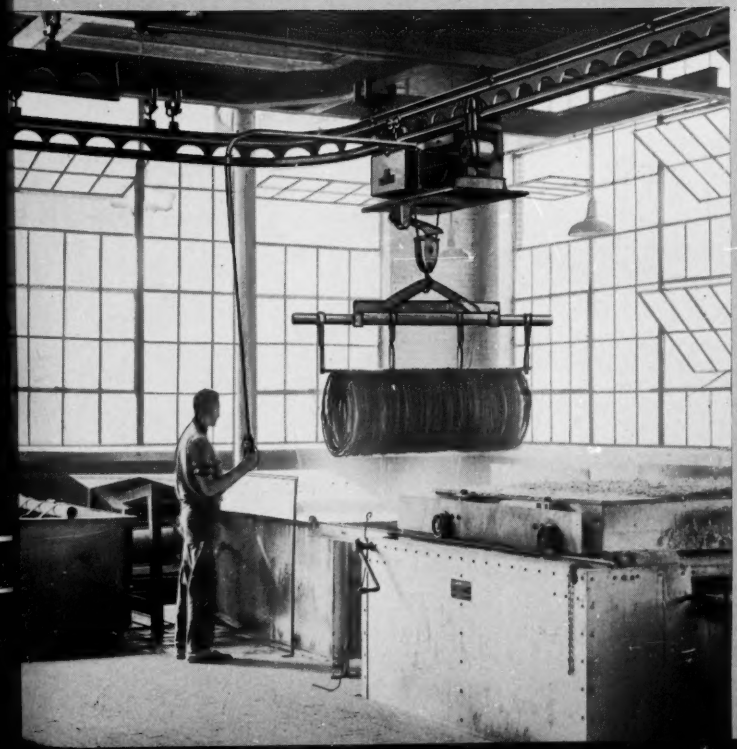
MORRISON ENGINEERING COMPANY INC.

5005 EUCLID AVENUE — MORRISON ENGINEERED — CLEVELAND, OHIO

IF IT'S A FLASH BAKER - MORRISON BUILT IT

CLEVELAND TRAMRAIL

Complete Systems for Overhead Handling of Materials and Products in All Departments of the Wire and Wire Products Industry



• Cleveland Tramrail is designed to meet the needs where loads are light and service is intermittent, as well as for the high speed heavy duty service required in the rod mill.

ALSO BUILDERS OF CLEVELAND CRANES ALL WELDED

CLEVELAND TRAMRAIL

DIVISION OF

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WHERE CAN WE GET IT?

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enables you to determine all sources of supply for

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Products Formed or Fabricated Wholly or in Part from Wire

Published and Revised annually

The 1939 edition is now being compiled

Advertising forms close February 15, 1939

Publication date March 1, 1939

THIS is the only permanent reference book available to buyers in this highly specialized industry and your advertisement in this Buyers Guide would undoubtedly create sales contacts for you.

✦ ✦ ✦

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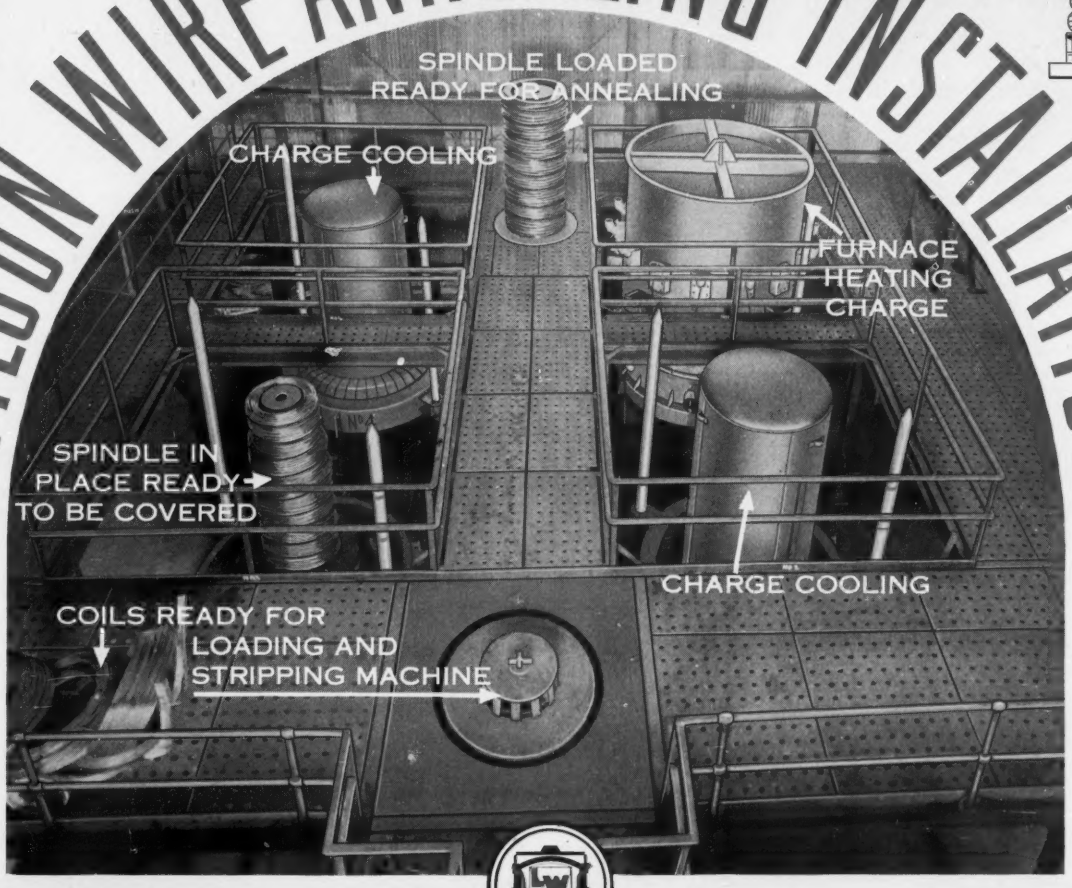
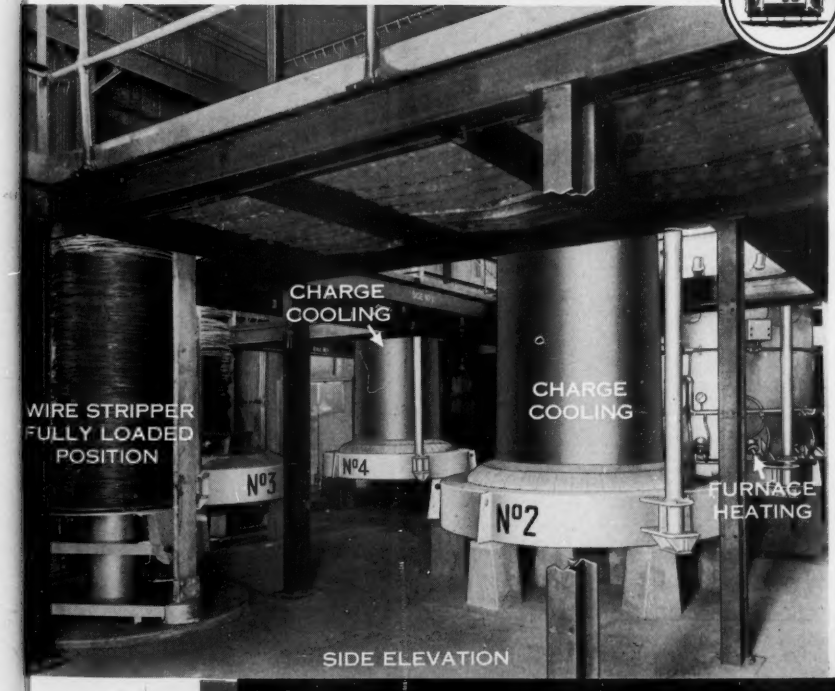
17 East 42nd Street New York, N. Y.

FOR FLAT WIRE

OR ROUND WIRE

Another WILSON WIRE ANNEALING INSTALLATION Completed





IN the past 3 months, the Townsend Company of New Brighton, Pa. have completed their Wilson wire annealing installation for process treatment. Charges of 5,000 pounds of wire and rod coils are annealed in 4 hours with Rockwell B test within 3 points throughout the entire load at a weekly average gas consumption of 1440 cu. ft. of natural gas per ton.

An Exclusive Development of

LEE WILSON ENGINEERING CO.

1370 Blount Street • Cleveland, Ohio

FARREL ROLLING MILL MACHINERY

ROLLING MILLS—For ferrous and non-ferrous metals. Complete rod mills from furnace to coilers.

ROLLS—Cupola and electric furnace chilled and alloy iron, heat treated Farrel Ni-Hard and steel.

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CINDER CRUSHERS

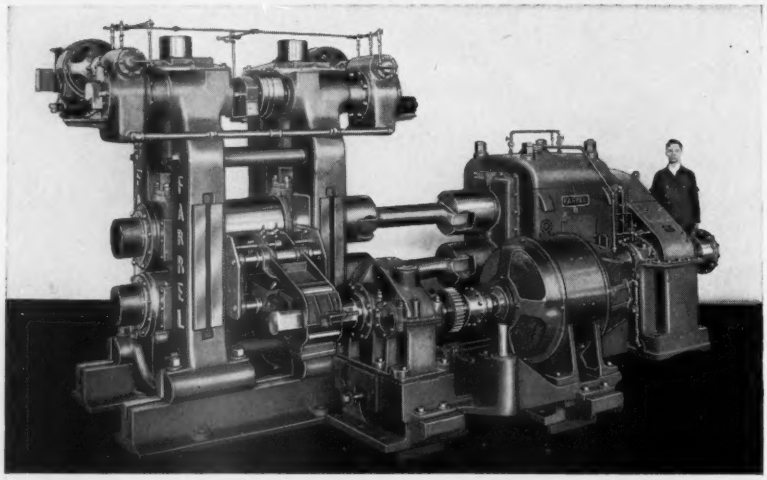
GEARS

MILL PINIONS

PINION STANDS

GEAR DRIVES

FLEXIBLE COUPLINGS

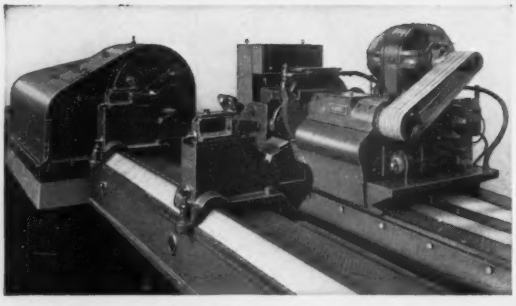


FARREL ROLLING MILLS

Built in any size for any specific requirement. Advanced features of design and construction permit high speed operation, increase output, improve quality and reduce production costs.

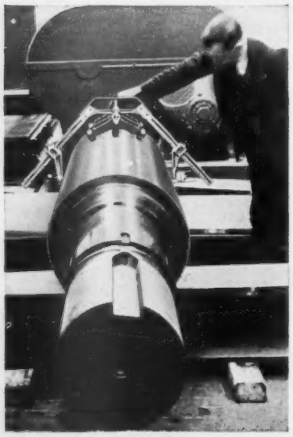
FARREL NI-HARD ROLLS

Superior in quality, precision and durability. Combine hardness of 85 to 90 scleroscope with high strength and flawless surface. Ideal for high finish sheets, they produce a higher quality finish, have longer life and cut ton-cost of output.



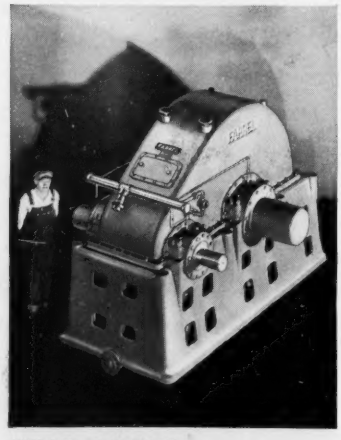
HEAVY DUTY ROLL GRINDERS

Designed for better, faster and cheaper grinding. Equally capable of heavy roughing or fine finishing on rolls of any material. Grind perfect surface free from marks of any kind, with straight, concave or convex contours of exact symmetry and accuracy. Built in six standard sizes to grind rolls up to maximum diameters of 24″, 28″, 36″, 44″, 50″ and 60″, and any lengths required.



ROLL CALIPERS

Provide exact check of roll accuracy. Five sizes to measure rolls from 4″ to 50″ diameter.



GEAR DRIVES

Single, double and multiple reduction units, any ratio, any speed, any power.

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.

ANSONIA, CONN.

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable

DRAWING—ROLLING—EXTRUDING—FORMING—FABRICATING

Vol. 14 JANUARY, 1939 No. 1

Designated as

Official Publication By The Wire Association

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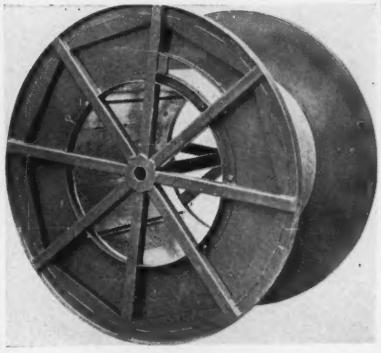
ALL STEEL
REELS

FOR SHIPPING
FOR STORING
CABLE AND WIRE



Last Longer

Constructed of corrosion resisting materials, three to four times the life of a wooden reel is a reasonable expectancy.

Give Greater Protection

Smooth inner surfaces, much greater strength with the absence of all cutting or abrading projections — these protect not only the cable but the men handling it.

Save On Freight

Appreciably lighter than wooden reels — cost less to ship — a cumulative saving that more than offsets increased first cost.

Reduce Investment

The longer life of R. B. Hayward Steel reels reduces the investment in reel equipment.

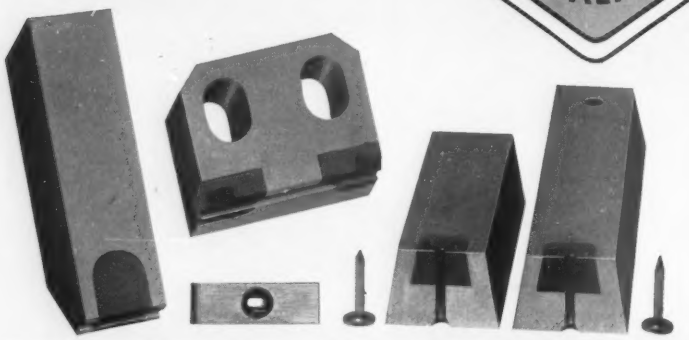
Write for description of construction and prices.

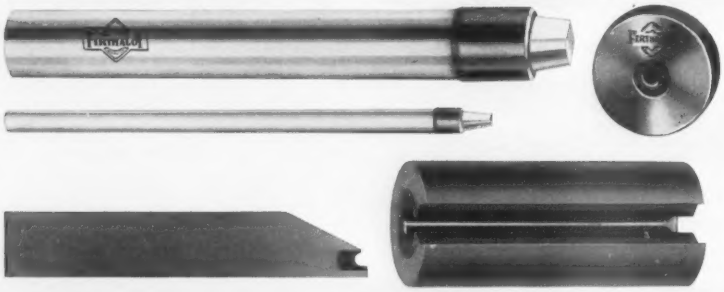
R. B. HAYWARD CO.

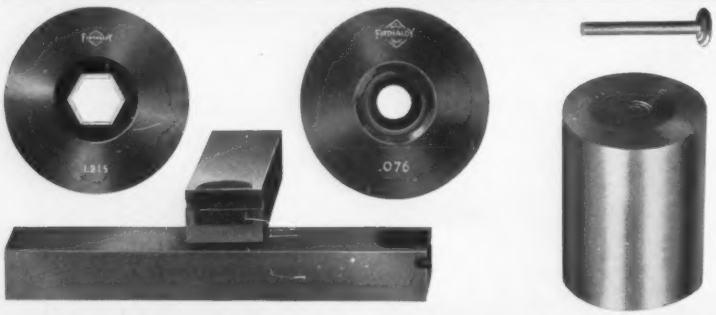
1714 Sheffield Ave.

Chicago, Illinois

FIRTH-STERLING
FIRTHALOY
QUALITY







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Fundamental Principles of Steel Wire Metallurgy

PART III — The Metallurgy of Steel Wire

By B. L. McCarthy,

Chief Metallurgist, Wickwire Spencer Steel Company,
Buffalo, N. Y.

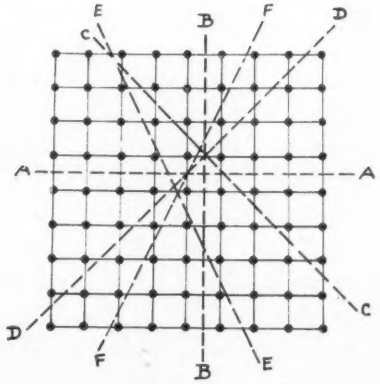
FOREWORD

This is the third of a series of three lectures delivered before the Wire Association October, 1938.

In these lectures the author has attempted to present the fundamental principles of steel wire metallurgy in a manner which will make it understandable to the layman.

Principles of Cold Work

IN previous lectures we have discussed the crystallinity of metals, and the fact that in the solid state they consist of numerous crystal units composed of atoms held in position by the forces of secondary valence. If a stress is applied to a metal a strain is set up which tends to alter the relation existing between the atoms. If the amount of strain developed is within the elastic limit of the metal, that is, if the forces which hold the atoms in position are strong enough to withstand the strain, when the stress is relieved the atoms will return to their original position and the metal will resume its original shape. If, however, the stress sets up a strain greater than that which the forces holding the atoms in position can withstand, a permanent altering of the position of the atoms will result, and a strained condition exist which will not be relieved even though the stress is removed. In this condition a metal is said to have been **cold worked.** If, because of excessive stressing, the strain developed is in excess of the forces which hold the crystals together, loss of cohesion will result and the metal will fracture. If, however, the stress be of the order which lies within the range between the elastic limit and the loss of cohesion, or ultimate strength, the metal can be repeatedly strained and a high degree of strength and hardness developed. It is in this manner, namely the application of stress between the elastic limit and ultimate strength, that the strength of steel wire is developed.



SLIPPAGE PLANES.

Showing a few of the many slip planes which may be present in a metal.

FIGURE L

✦ ✦ ✦

THE geometric arrangement of the atoms makes possible numerous planes along which the movement resulting from cold work can take place, and the deformation associated with it is by virtue of block movements of crystal units, or slips, along these

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planes. To best visualize these **slip planes** the diagram shown in figure L was prepared. Here we have a two dimensional space lattice, the black dots representing atoms, upon which is drawn, in broken lines, a few of the possible planes that can exist.

✦ ✦ ✦

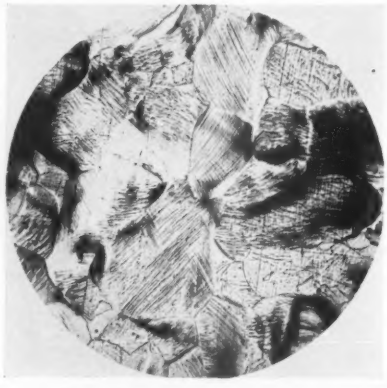
WHEN a metal is cold worked the block movement of crystal units which first takes place, is along planes which offer the minimum amount of resistance to slip, called **planes of easiest slip.** This movement however, can proceed only to a limited extent because of the resistance to slip afforded by grain boundaries. As has already been shown, the planes in which the cube faces lie, change from grain to grain and accounts for the presence of grains. If, therefore, a metal is cold worked causing slip along certain planes, the fact that the same planes are not continuous, but change from grain to grain, provides resistance to slip, or block movement, of the crystal units. If the grains are large, more movement can take place with less interference due to grain boundaries, because of this, the ductility of a metal will vary with the grain size.

✦ ✦ ✦

AFTER the first application of cold work has caused movement along planes of easiest slip, further cold working will result in slips along other planes which offer more resistance. Each slip that occurs therefore, so alters the relation between the atoms as to increase resistance to further slip. If for example a slip occurs along plane A, figure L which results in a shifting of the atoms which bound it, it will interfere with the slip along the planes which cross it, in the same manner all slips or movements of atoms which bound planes produces resistance to movement along planes which cross. In this manner metals harden from cold working by building up increased resistance to further deformation.

✦ ✦ ✦

IN figure 30 is shown a photomicrograph which demonstrates the manner in which slips occur. Note the lines within the grains. These are slip planes, note how these lines are not continuous



Low Carbon Steel showing how slips of crystal unit occur within the grains. Magnification 200X.
FIGURE 30

from grain to grain, but change their direction at the grain boundaries. This sample was prepared by polishing and etching a low carbon steel and then subjecting it to strain. The lines are the result of a definite movement of the crystal units.

✦ ✦ ✦

IF we are dealing with a pure metal in which the atoms are identical in size the resistance to cold working is less than if we have a solid solution containing two or more atoms varying in atomic volume. The reason for this is that in a metal containing atoms which differ in size the number of planes along which slip may occur are reduced and the resistance, or interference to slip, increased. In the same manner fine particles of hard precipitated constituents such as intermetallic compounds increase the resistance to cold working or plastic deformation, because they reduce the amount of movement that can take place without interference, to slip; that is, they offer obstruction to block movement of crystal units along planes of easiest slip.

✦ ✦ ✦

WHENEVER a metal is deformed these principles of cold work apply, whether it be in physical testing such as **tensile strength** determinations where the metal is stressed longitudinally to the point of fracture, **hardness testing** where an instrument is forced against the metal and the hardness value is a direct indication of the amount of resistance to deformation present in the metal, or **twist test** where the cold working is the result of twisting strains causing an elongation of the outer surface of the metal.

✦ ✦ ✦

THE measure of **elastic limit,** wherein the material is strained to a point beyond which it will not return to its original shape when the stress is removed,

TABLE III
Effect of Repeated Cold Working on Low (A) and High (B) Carbon Steel

	Before Drawing		30% Reduction		55% Reduction		70% Reduction	
	A	B	A	B	A	B	A	B
Tensile Strength lbs. per Sq. Inch	54000	136000	68000	160000	88000	176000	104000	192000
Elastic Limit lbs. per Sq. Inch	33000	82000	65000	155000	86000	*	*	*
Hardness—Rockwell	60-B	30-C	74-B	35-C	87-B	38-C	94-B	40-C
Elongation in 10"	24%	8%	3½%	3%	3%	2½%	2½%	1.5%

*—Not Determined.

Note:—The elastic limit value employed herein represents the load required to effect a permanent set, in the sample being tested, when the load was removed.

may be employed as an indication of how much stress can be applied within the limits of the forces of secondary-valence, before the original relation of the atoms is permanently altered. After each application of cold work however, a new atomic relationship is established of a higher order of strain than existed prior to cold working.

✦ ✦ ✦

IN wire drawing any reduction in cross sectional area which takes place is the result of the development of strains beyond the elastic limit and the increase in hardness is the result of increased resistance being developed in the metal along the lines previously mentioned. In table III is shown the changes in physical properties which take place when steel is cold worked by drawing a number of times. A represents a low carbon (.08) steel, B a high carbon (.58) steel.

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THE increase in tensile strength and hardness is the result of an increase in resistance to deformation, as previously stated. The small amount of change in the elastic limit on subsequent drafts is because the original draft strained the metal beyond its elastic limit, subsequent drafts therefore were made on an already strained material. All cold worked metal exists in this strained condition. The **elongation** or the amount the wire will stretch before fracture in a unit length, is lowered appreciably with the initial application of cold work and is affected very little from that point on.

Strain Distribution

THE uniformity of strain distribution across the diameter of the wire is an important factor which influences its ductility, and depends on the uniformity of the metal being cold worked. In pure metals or solid solutions where there is no precipitated constituents the only variations in strain distribution which can exist are those resulting from grain size variations. In metals containing precipitated constituents which are harder than the metal in which they occur, a microscopic variation in strain distribution will develop on cold working because of the ability of the harder constituent to withstand the cold working stresses. For a given percentage of reduction of the cross sectional area, this resistance of some areas places an extra burden on adjoining softer areas. If the precipitated constituent is extremely hard as in the case of the Intermetallic compound, Iron Carbide, it may offer almost complete resistance to deformation and the added amount of deformation which adjoining areas are forced to absorb for a given size reduction may result in sub-microscopic fractures in the wire which will greatly reduce its ductility.

✦ ✦ ✦

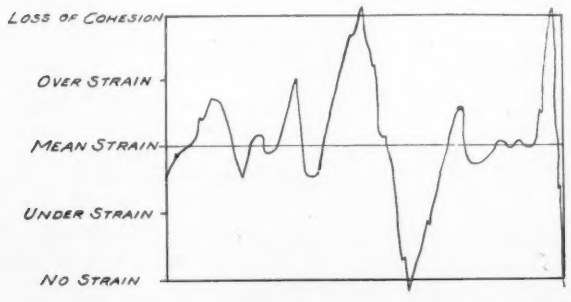
IN figure M is shown diagrammatically, the manner in which the distribution of strain can vary in a piece of wire from the mean strain value, to loss of cohesion or point of fracture on one side, and absence of strain on the other. Hard particles of cementite would represent the unstrained portion, while soft ferrite areas adjacent to it would be strained to the point of fracture. The size, shape and distribution, of the precipitated particles play an important part in the distribution of strain, pearlite for example, which consists of alternate plates of cementite and ferrite will produce more resistance to cold work than ferrite and in low carbon steel will cause the steel to harden quicker than if the carbon is in the form of spheroids of cementite. At the same time the ferrite plates produce a cushioning effect which makes pearlite readily workable. High Carbon steel is drawn from a pearlitic structure, the quality of it however, depends on the plate thickness and the relation between the direction of the plates and the application of pressure.

✦ ✦ ✦

THICK plates of cementite offer greater protection to the ferrite than do thin plates and will require a higher order of stress to deform them. Because of this and the fact that high carbon steel which consists primarily of pearlite when properly prepared for wire drawing, always contains some variation in the plate thickness in different areas, it is advisable to continue cold working on this material to a point where the reduction in cross sectional area is at least 60%, to insure a high degree of uniform strain distribution.

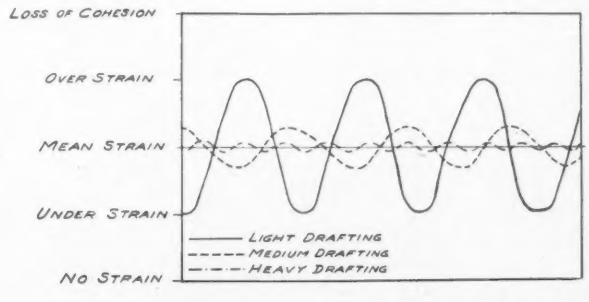
✦ ✦ ✦

IN figure N is shown diagrammatically the manner in which increased drafting promotes strain distribution. The first application



Strain Distribution associated with Cold Working of Metals containing Hard Particles which do not Deform.

FIGURE M



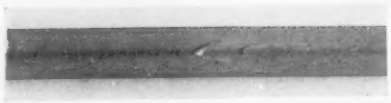
Distrbution of Cold Working Strains.

FIGURE N

of cold work is effective in the softer areas. As these areas harden other areas are affected. In this manner deformation proceeds by increasing the hardness of softer areas until all portions assume the same degree of hardness and if the steel is in a suitable condition the quality of the wire, which combines strength with ductility, will improve with cold work. It is remarkable to what extent (sometimes over 95% reduction) cold working in the form of wire drawing can be carried before an overdrawn condition, or fracture, develops in steel properly prepared for drawing. The term **"overdrawn"** used here does not necessarily imply too much drafting or improper drafting. If the steel is not in proper condition it may be overdrawn after only small amount of reduction has been made.

✦ ✦ ✦

WHEN, because of the presence of areas, which have a decided resistance to plastic deformation, certain areas become seriously overworked, it is not uncommon for internal fractures to develop. Wire in this condition breaks with a cup-like fracture and is termed **cuppy wire.** In figure 31 is shown a section of a steel wire containing internal fractures. This wire was extremely brittle. Note the directional tendencies of the fracture, this accounts for the cuppy condition. While it is possible to develop this condition as a result of poor heat treatment, most cuppy wire is due to



Cuppy Wire. Magnification 6X. ✦
FIGURE 31

a segregation at the axis of the wire.

✦ ✦ ✦

WHEN wire is drawn, the deformation is the result of pressure being applied to the wire surface at an angle perpendicular to the taper of the die. If, therefore, the plates of cementite and ferrite of some pearlitic areas are parallel to the application of pressure, greater resistance to deformation will result, than if the plates are other than parallel to the pressure application. Coarse pearlite in which the plate thickness is large may offer enough resistance, because of the plane in which the plates lie, to render the material unsuitable for wire drawing purposes.

IN low carbon steel, because of the plasticity of the ferrite and the amount of it present, pearlitic areas can resist deformation to a large extent and changes in the amount of carbon can alter the tensile strength appreciably. The presence of the cementite in the spheroidal form rather than the plate form is desirable in this case, because the total amount of resistance is lowered and the steel will harden less on cold working than when the carbon is in the form of pearlite, in which form, it occupies a much larger portion of the cross sectional area. On the other hand, because of the permanent resistance to deformation afforded by spheroidal cementite and the amount present, high carbon steels can become very brittle if the structure is one of spheroidal cementite rather than pearlite. For this reason the best high carbon wire is always produced from the structure of fine pearlite—see figure 33-A.

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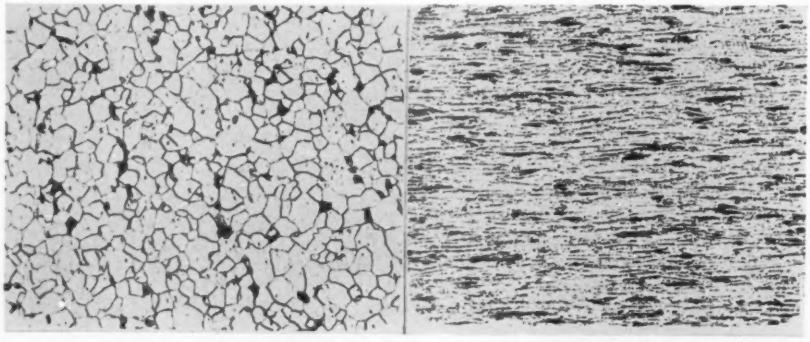
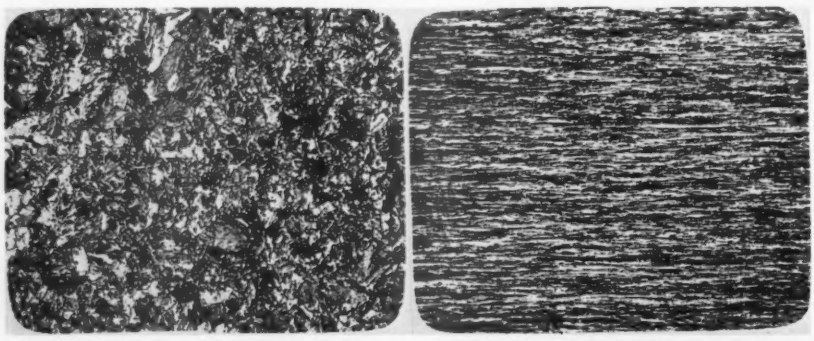


A—Before Wire Drawing B—After Wire Drawing
Low Carbon (.08) Steel. Magnification 200X. ✦
FIGURE 32



A—Patented Condition B—After Wire Drawing
High Carbon (.65) Steel. Magnification 200X. ✦
FIGURE 33

BECAUSE of the taper of the die and the fact that the pressure is applied in a line perpendicular to it the deformation associated with wire drawing produces both elongation and reduction in cross sectional area, and the original grains which are polygonal and equiaxed in the hot-rolled or heat-treated material prior to drawing, are compressed and elongated. In figure 32 is shown the structure of a sample of low carbon steel before and after wire drawing. In figure 33 is shown the struc-

ture of a high carbon steel both in the patented condition and after wire drawing.

✦ ✦ ✦

Effect of Cold Work on Other Properties

AS has been shown the increase in tensile strength and hardness resulting from cold work is by virtue of an alteration in the atomic relations. In the heat treated condition a better balancing of forces of secondary valence is provided and a minimum amount of unbalanced atoms obtains. When, however, the then existant relation of the atoms is altered, a general unbalancing of secondary-valence forces results. This not only alters the strength and hardness of the metal but is also reflected in its solubility in acid, magnetic properties and conductivity. The solubility is increased, while the magnetic properties and conductivity are decreased.

✦ ✦ ✦

Analyses

STEELS for wire drawing purposes may be divided into two major groups:—

GROUP 1—Those wherein we depend on the ductility of the free ferrite for plasticity.

GROUP 2—Those wherein we depend on the ductility of pearlite for plasticity.

✦ ✦ ✦

GROUP 1 embraces a range in carbon from 0 to .15 while Group 2 from .45 up.

✦ ✦ ✦

THE amount of ferrite present in the first group is sufficient to absorb the strains resulting from cold working, as the **carbon** content increases however the amount of pearlite increases and the amount of ferrite decreases. This reduces the amount of size reduction or deformation that is available in the ferrite and causes some deformation of the pearlitic areas. Between .15 and .45% carbon there is insufficient ferrite to absorb cold work and particularly in the higher limits of this range a large portion of the deformation takes place in the pearlitic areas. Because of the difference in hardness between these areas, severe working of the ferrite is required to bring its hardness up to the hardness of the pearlite. This tends toward brittleness and steel within this range of carbon is not well suited for wire drawing.

✦ ✦ ✦

WHILE there is a considerable amount of wire produced from steel within this range of analysis, it is generally employed for some special application where the analysis is the important factor and only a limited amount of cold working is employed; such as steel for cold heading purposes. Above .45 carbon lies the range in which we look to the cold working of the pearlite and it is desirable that the patenting treatment be controlled so that a minimum amount of free ferrite is precipitated at the grain boundaries. When, instead of being present at the austenitic grain boundaries, the free ferrite is found intimately mixed with the pearlite the fact that to deform it requires deformation of the pearlite, reduces the tendency towards the over-working of it. At the same time the amount of ferrite present has an influence on the tensile strength developed and the tensile strength of high carbon steels will vary as the amount of free ferrite or the carbon content varies.

✦ ✦ ✦

WHEN the carbon content exceeds .90 or thereabout, the excess constituent is cementite instead of ferrite and we are dealing with hyper-eutectoid steels. The free cementite will offer almost permanent resistance to deformation and all the burden of plasticity will rest with the pearlite. In this case, the presence of free cementite offers resistance to cold working beyond that of the pearlite and hyper-eutectoid steels will harden quickly as a result of cold working.

✦ ✦ ✦

BECAUSE of the variable combinations of carbon and manganese needed to produce a steel of truly eutectoid composition, it is seldom encountered, however, in eutectoid and hyper-eutectoid steels all the cold-working is the result of the plasticity of the pearlite, while in hypo-eutectoid steels both the free ferrite and pearlite are deformed.

IN view of the importance of the condition of pearlite and its relation to plasticity it is obvious that some treatment such as patenting is needed to properly condition the steel.

✦ ✦ ✦

MANGANESE, Phosphorus and Silicon form a solid solution with the ferrite and because of the presence of different size atoms increase resistance to cold-working in proportion to their percentages. **Manganese** is added to higher carbon steels for this specific purpose and has a decided influence on the tensile strength produced in hypo-eutectoid steels by cold work. Because of the fact that it also forms an iron-manganese-carbide, it delays the rate at which the austenite→pearlite and ferrite reaction takes place and tends to produce a finer pearlitic structure on air-patenting. In the hyper-eutectoid and eutectoid steels, such as are employed for music wire the manganese content is between .30 to .50%. This type of steel should always be lead-patented to induce a finer pearlitic structure.

✦ ✦ ✦

SULPHUR plays a very small part in determining the properties of steel wire, present as it is in the form of a non-metallic inclusion, Manganese-Sulphide, it flows with the cold work and offers little resistance to deformation. If it is present in large quantities (over .075) however and highly segregated it tends to induce brittleness, but in ordinary steel containing .05% sulphur or under, it has little influence.

✦ ✦ ✦

PHOSPHORUS as previously stated forms a solid solution with the ferrite. Unlike manganese however, phosphorus segregates badly and sets up a non-uniform strain distribution which tends to stiffen the wire. For special application where stiffness is required, as for curtain rods, it is desirable; for the general run of steel however, it is considered objectionable.

✦ ✦ ✦

SILICON may vary from .0 to .30%. A large portion of the low carbon steel wire being pro-

duced today is made from **Rimmed** or **open steel.** This steel is produced by a process wherein the amount of oxides present are maintained at a balance which produces a degree of fluidity, and selective freezing results. This makes possible the formation of an almost pure iron-rim on the steel with the center more highly segregated. The addition of only a small amount of Silicon will destroy this tendency and silicon treated steels are more uniform generally throughout their cross section than rimmed steels. At the same time Silicon treated steels have a finer grain size generally than rimmed steels, this causes them to harden quicker on cold-working. Only a small amount of silicon can make a decided change in the hardness of low carbon steel after cold working. In Table IV is shown the tensile strengths developed in two steels of almost identical analysis except that one was rimmed while the other was treated with silicon.

✦ ✦ ✦

IN figure 34 a and b are shown photographs of a rimmed and silicon-treated low carbon steels taken on the cross section of a 1¾" billet which has been polished and deeply etched. Note the rim or picture-frame effect in the rimmed steel as compared with the silicon treated steel.

✦ ✦ ✦

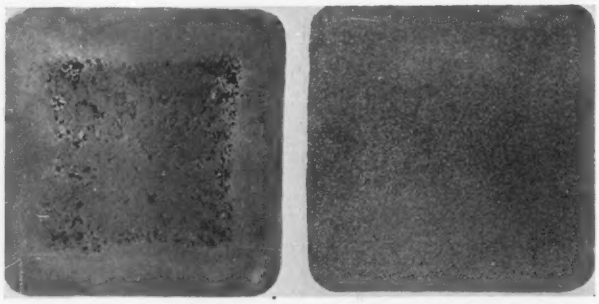
IN figure 35 a and b is shown two photomicrographs of rimmed steel, one taken at the center and one in the rimmed area. Note the difference in grain size. This is due to the presence of impurities in the center which tend to obstruct grain growth. In figure 36 is shown the structure of a steel containing .05 Silicon but otherwise resembling in analysis the steel shown in figure 35, note the difference in grain size.

✦ ✦ ✦

IN higher carbon steels silicon is beneficial because the prime purpose of adding silicon is to reduce dissolved Iron-oxide. As the Silicon content is raised up to .20 there is a decided improvement in the response of the steel to patenting, above this point there is little noticeable effect.

TABLE IV
Effect of Silicon Additions on
The Tensile Strength of Low Carbon Wire

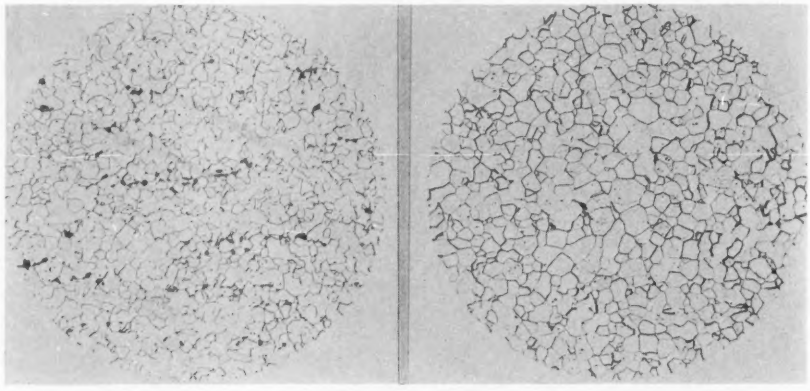
	Tensile Strength lbs. per Sq. Inch			
	Rimmed Steel		Silicon Treated Steel	
	Carbon .06	Silicon 0	Carbon .06	Silicon .08
#5 Rod	52000		56000	
Drawn 30%	68000		72000	
Drawn 55%	82000		88000	
Drawn 70%	91000		100000	



A—Rimmed Steel .06 Carbon. ✦ B—Silicon Treated Steel .07 Carbon —.10 Silicon. ✦ ✦

Taken on 1¾ Billet. Actual Size. ✦ ✦ ✦ ✦ ✦ ✦

FIGURE 34

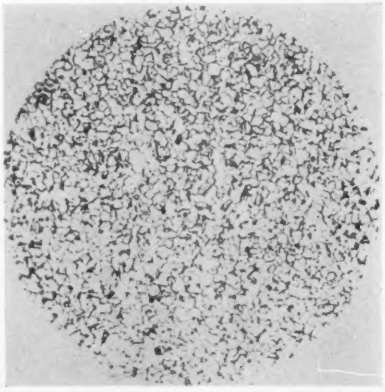


A—Taken at Center

B—Taken in Rimmed Area

Rimmed Steel. Magnification 100X. ✦ ✦ ✦ ✦ ✦ ✦

FIGURE 35



Silicon Treated Low Carbon Steel. Magnification 100X. ✦ ✦ ✦ ✦

FIGURE 36

Alloys

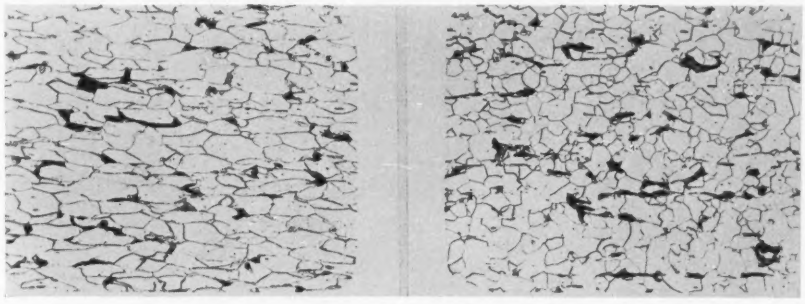
EXCEPT for special purposes such as stainless steels or cases where the wire is to be subsequently heat treated to bring out some special properties, the addition of alloys to steels for wire drawing purposes is not considered beneficial. Alloys such as Chromium, Nickel, Molybdenum, etc., which form a solid solution with the ferrite set up considerable resistance to cold work and in the cold worked condition offer no advantages beyond those which can be obtained by the use of man-

ganese in hardening or toughening the ferrite. Those which form carbides, only accelerate the action of carbon and inasmuch as carbon and manganese can be added to obtain the desired hardening effect, they offer no special advantages.

✦ ✦ ✦

Annealing

IN general the term annealing is employed to indicate slow cooling from a temperature above the critical range. In annealing steel wire, however, experience has shown that a temperature just below that at which transformation takes place produces the best results. Because of this, steel wire is annealed at a temperature of 1250°F to 1300° F. To distinguish this treatment from annealing in general, the term **process anneal** is employed. As previously shown, iron which has been cold-worked recrystallizes at about 900°F. After this temperature is passed, therefore, the cold-working strains are relieved from the ferrite, and the elongated crystals become equiaxed. Because a temperature of 1333°F or higher is required to effect the recrystallization of the pearlitic areas, they remain elongated. In figure 37 is shown a sample of steel wire before and after heating to 1100°F for 30 minutes. Note how annealing has altered the ferrite; the pearlitic (dark) areas are still elongated however. To produce maximum strain distribution it is advisable to break up the pearlitic areas and replace them with spheroids of Iron-Carbide in a Matrix of ferrite. It becomes desirable, therefore, to heat the steel to as near 1333°F as is practical, to accelerate the spheroidization of the cementite. If, however, the temperature at which the cementite and ferrite of the pearlite dissolve in each other (1333°F) is exceeded, the solid solution of austenite will be formed and subsequent cooling will again produce pearlite. In figure 38 is shown two photomicrographs of annealed low carbon wire; A was taken at 200 X, B at 2000 X. Note the spheroids of cementite.



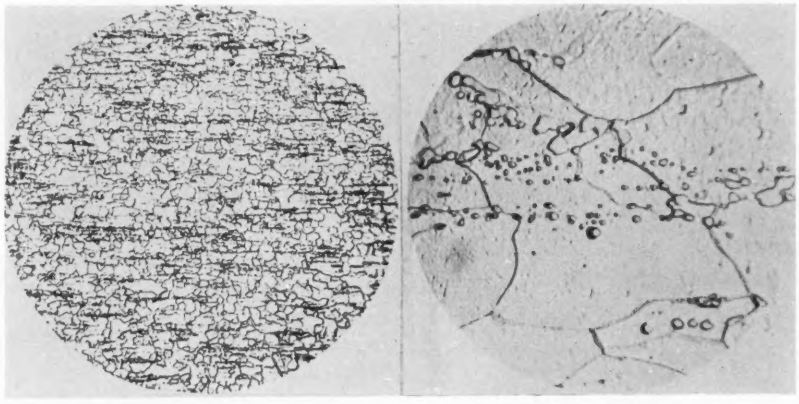
a—After Drawing b—After Annealing A for 30 minutes at 1100°F.

Showing how Ferrite recrystallizes on heating to 1100°F, while pearlite does not.

Tensile Srength
a—82000 lbs. per sq. inch
b—52000 lbs. per sq. inch

FIGURE 37

✦ ✦ ✦



A—Magnification 200X B—Magnification 2000X

Annealed Low Carbon Wire.

FIGURE 38

✦ ✦ ✦ ✦ ✦ ✦ ✦ ✦

THE process anneal is employed principally on low-carbon material. It serves to relieve cold working strains and enables the wire drawer to continue size reduction without overdrawing the wire. When a small size wire is being produced it is not uncommon to employ two annealings during the process of drawing. Annealing is also used to develop low tensile strength, and some wire is annealed after the final draft to produce the extreme in softness. Again, a high finish may be desired with low tensile properties; here the wire may be drawn, annealed and given one light draft. In figure O is shown the manner in which annealing is employed to

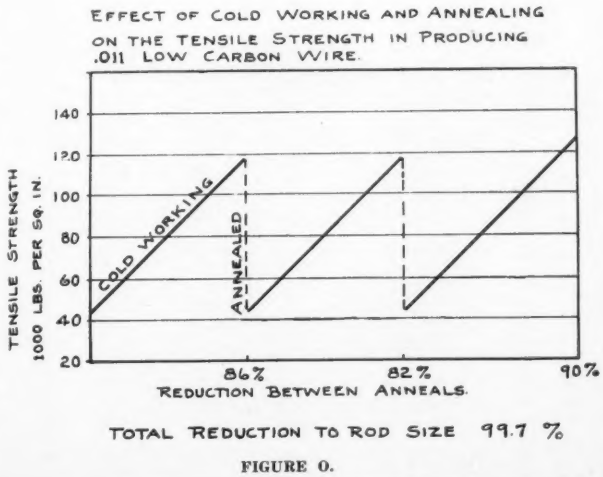


FIGURE O.

reduce cold working strains in processing .011 low carbon wire.

✦ ✦ ✦

UNDER normal conditions the grain size after annealing will approximate the grain size of the hot rolled rod; under certain condition of strain, however, it is possible to develop extremely large grain. This type of grain growth, which is associated with low-carbon steel (.15 c and under), is confined to a low strain condition in the steel not exceeding the equivalent of 20%. To avoid this grain growth all low carbon steels should be given a reduction of at least 30% in cross sectional area prior to annealing. In figure 39 is shown the extent to which grain growth may develop. This sample was drawn 9% followed by annealing at 1350°F for 12 hours.*

✦ ✦ ✦

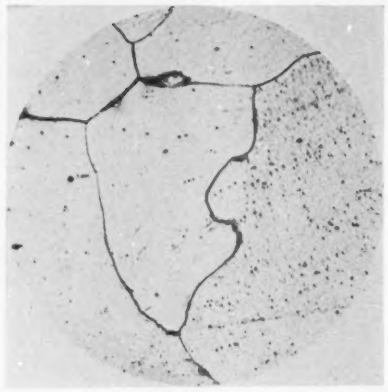
WIRE is usually annealed in pots placed in a suitable furnace. A stem is provided which consists of a base with an upright over which the wire is placed. A cover is provided for the top of the pot to reduce the amount of scaling of the wire during heating and cooling.

✦ ✦ ✦

SALT baths are being used extensively for annealing steel wire and by their use it is possible to reduce greatly the time of annealing and produce a marked degree of uniformity. This time reduction is at the expense of complete spheroidization, and salt bath annealed wire is never completely spheroidized. The limited amount of benefit derived from complete spheroidization does not make this an important factor, and salt bath annealed wire can be drawn with approximately the same results as the pot annealed wire.

✦ ✦ ✦

CONTINUOUS annealing, which consists of running the wire from a reel or swift through a suitable furnace, and then winding it up on a take-up block, is sometimes employed for special



Grain Growth in Low Carbon Steel. Wire drawn 9% reduction in area followed by annealing for 12 hours at 1350°F. Magnification 200X.
FIGURE 39

purposes. This type of annealing is generally used prior to Galvanizing; it serves to burn off the soap or lubricant remaining on the wire from the last draft, and to make it clean freely. At the same time, by combinations of time and temperature, it is possible to produce a wide range in tensile strength. Very often a single or double lead bath is employed for continuous annealing. This method of heating, is both fast, and accurate in control of the tensile strength of the annealed wire.

✦ ✦ ✦

CONTROLLED atmosphere is being employed extensively in the annealing of wire, and complete installations which include a modern pot annealing equipment and controlled atmosphere are available. They are both efficient and fast, and scale loss is reduced to a minimum.

✦ ✦ ✦

Patenting

THE word "patenting" is derived from an old English usage of the word "patent", employed to indicate a somewhat mysterious heat treatment which improved the quality of steel wire produced from stock so treated. It consisted then, as now, of passing the wire in strands through a suitable furnace wherein the steel was heated to a temperature above 1500°F. Patenting was employed originally to replace the annealing of Rods or wire in coil form, and in view of the greater uniformity resulting from strand cooling, as compared with cooling in coils, the early advantages associated with its use are readily apparent. Later in the course of the development of the patenting treatment, the advantages gained by a controlled cooling became apparent, and a molten lead bath was placed at the outgo end of the furnace to provide a means of controlling the rate of cool. For a period this was the accepted patenting process, and while today it is still used for some applications, it has been replaced to a large extent by the Air Patenting process wherein the wire is brought direct from the furnace and allowed to cool in air at atmospheric temperatures. This method resembles the original process, but with more advanced developments has attained a degree of refinement not present originally.

✦ ✦ ✦

WHETHER the **cooling medium** is lead or air, the same general principles of controlling the cooling rate are involved. Patenting is sometimes referred to as a normalizing treatment, and in the general usage of the term, it is a form of normalizing. However, the fact that not the normal rate of cooling, but an induced rate, with the definite intention of meeting certain physical requirements is employed, entitles it to special classification.

✦ ✦ ✦

IN patenting, whether the cooling is by means of molten lead or air, the purpose is to dissolve the constituents of pearlite, ferrite and cementite, and any excess constituents present, to form the solid solution of carbon in iron termed austenite; and then control the temperature at which it transforms on cooling. In this manner the fineness of the pearlite and the amount of free ferrite or cementite which is precipitated at the grain boundaries can be controlled.

✦ ✦ ✦

Air Patenting

THE control of the physical properties of air-patented material is a function of time and temperature. If the steel is brought to a relatively high tem-

***For more complete story on Grain Growth in Low Carbon Steel refer to "Grain Growth in Low Carbon Steel" —Wire and Wire Products, October, 1937, by the author.**

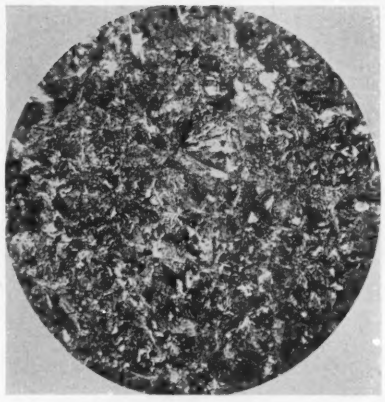
perature say 1800°F, and sufficient time allowed for solution and grain growth, it is possible to appreciably lower the temperature at which transformation occurs. When grain growth is combined with cooling from a high temperature, physical characteristics can be developed in the patented stock which promote cold working properties, and the subsequent cold working, associated with wire drawing, will produce high quality wire.

✦ ✦ ✦

PATENTING furnaces vary in length from 30 to 60 feet depending on whether wire or rods are being treated and the speed desired. They usually contain two or three zones which vary in temperature. The in-go end of the furnace should be the higher temperature zone and very high temperatures can be successfully employed at this point to promote the solution of the constituents. The center of the furnace represents an intermediate temperature between the high of the in-go end and the low of the out-go end. In this center zone time is provided for the completion of solution, diffusion of the elements throughout the austenite and austenitic grain growth. The out-go end of the furnace may be as low as 1600°F or vary from this to 1800°F depending on the size of the wire or rod and the desired physical properties. While some patenting furnaces have definite zones, individually heated, which are very effective, the same general principle of heating can be followed by using one or more burners at the in-go end and allowing the flame and burned gases to sweep to the out-go end. In this manner the temperature gradient from the in-go end to the out-go end can approximate the zoning principle.

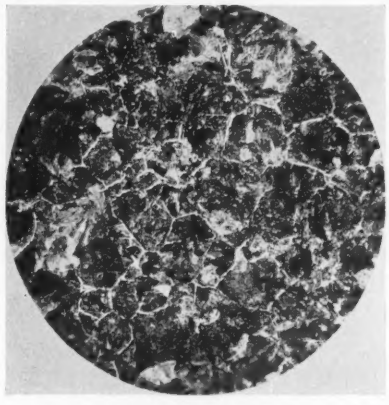
✦ ✦ ✦

INASMUCH as the air patenting is generally employed on steels between .45 and .80 carbon, our references will be to Hypo-Eutectoid steels only. Every heat of steel has a definite tensile strength which it is desirable to obtain in the patented stock. This tensile strength represents about the maximum which can be obtained on a given analysis by this process. If we start a rod or wire through the patenting furnaces at a given temperature, or given temperatures for the various zones, beginning with a high speed and gradually lowering it, and test the steel so patented for tensile strength, it will be found that it will first drop, from that of the steel prior to patenting, and then increase with the decrease in speed until a point is reached where further speed decrease will show no further increase in tensile strength. This is the desired tensile for a given steel being air patented. If higher or lower temperatures, within reasonable limits, are employed, some adjustment of speed will be necessary but the same tensile properties can be obtained. All air patenting should be done in this manner for best results and any variations in tensile strength of the finished wire should be by analysis and amount of drafting. Any attempt to produce lower tensile wire by patenting to a lower tensile will tend towards improper patenting and the quality of the finished wire will be impaired.



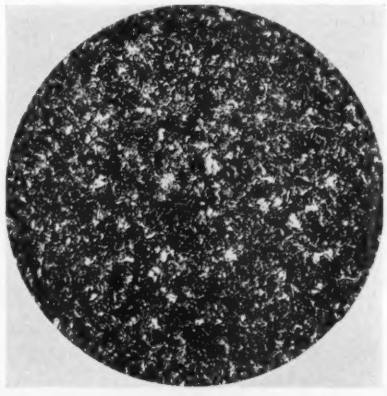
Air Patented—.65 Carbon #5 Rod. Magnification 200X.

FIGURE 40



Air Patented—.50 Carbon #5 Rod. Magnification 200X.

FIGURE 41



Lead Patented—.65 Carbon #9 Wire. Magnification 200X.

FIGURE 42

✦ ✦ ✦

IN figure 40 is shown the desired air patented structure of a .65 carbon—.80 manganese #5 rod. If a lower carbon content is employed, even with the desired tensile characteristics there will be some free ferrite present in the microstructure which will form a broken net-work around the old austenitic grains. This is shown in figure 41 which is the air patented structure of .50 carbon—.90 manganese #5 rod.

✦ ✦ ✦

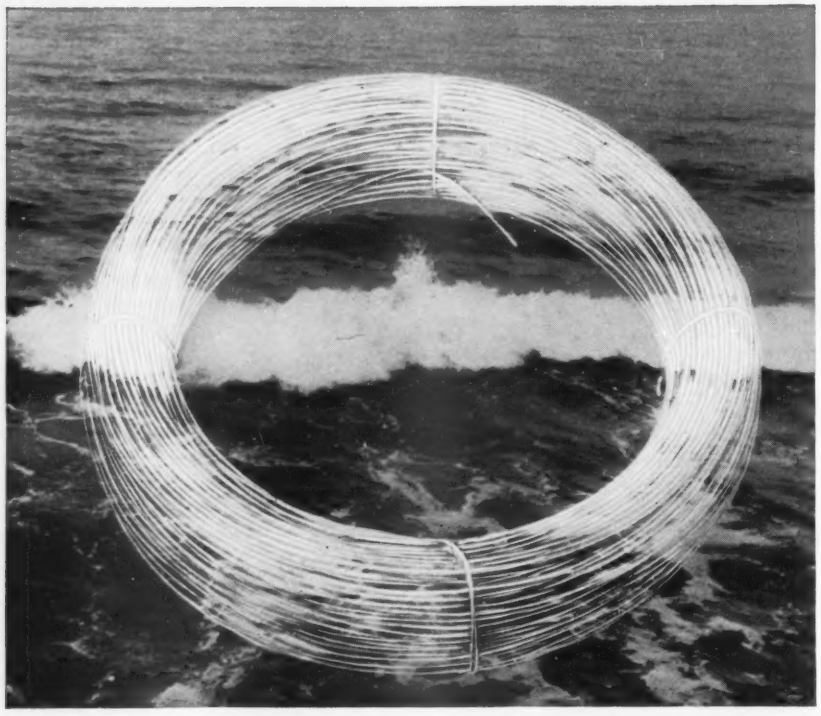
THE desired grain size of the patented rod or wire may vary depending on the size of the material being treated, the amount of size reduction intended for the finished wire, and its desired physical properties.

✦ ✦ ✦

Lead Patenting

IN the lead-patenting process the wire or rod is directed from the furnace at a temperature of about 1650°F into a lead bath maintained at 1000°F or thereabout. This sudden drop in temperature produces a further lowering of the Ar_1 transformation, than is obtainable by **Air-Patenting,** and a finer pearlitic structure results. At the same time precipitation of

(*Please turn to Page 79*)



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PROCEEDINGS

The Wire Association 1938 Meeting

DETROIT, MICH., OCTOBER—17-18-19-20, 1938

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"Industrial Mobilization", an Address Delivered by Col. Louis Johnson, Assistant Secretary of War, at the Wire Association Convention Luncheon will be found on Page 678 of the November, 1938 issue.

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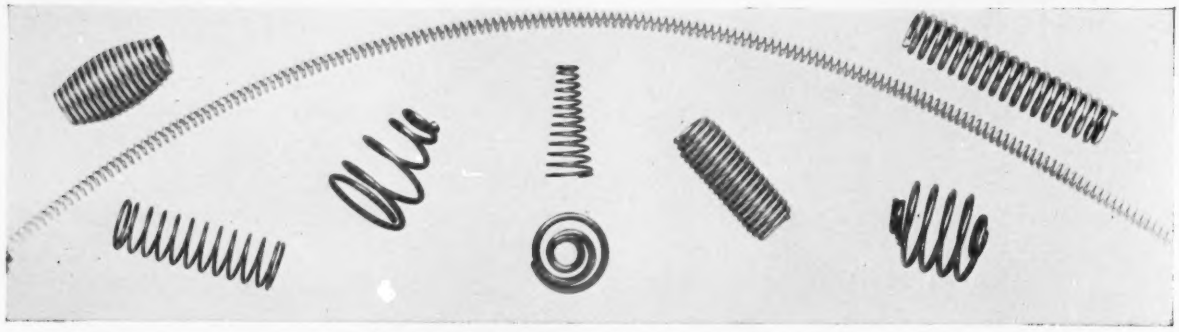

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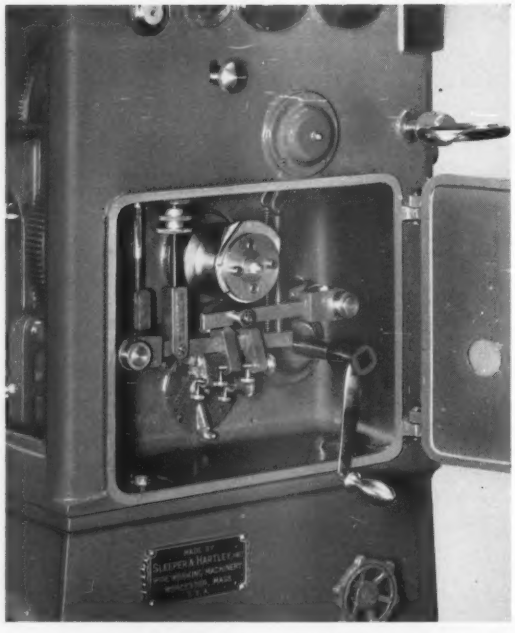

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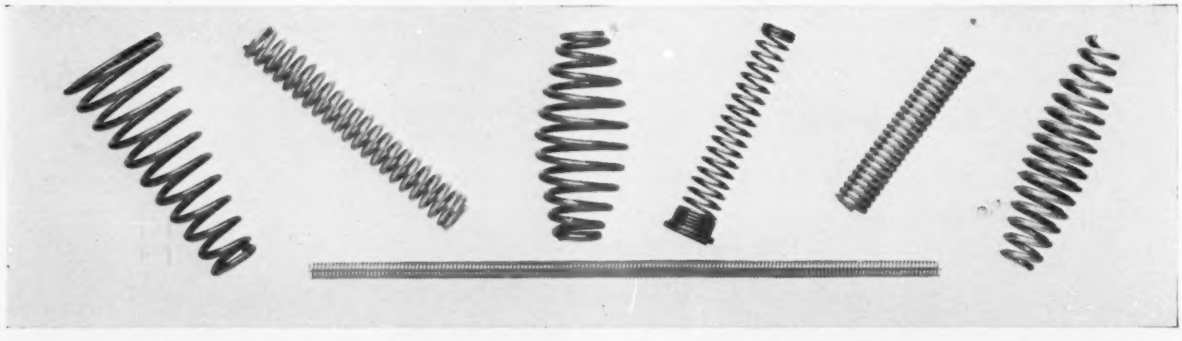

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FERROUS DIVISION

Meeting, Monday, October 17, 1938 - 2:30 P. M.

Chairman of Meeting

Ralph K. Clifford, General Works Manager,
Continental Steel Co., Kokomo, Ind.

PAPER: "RESILIENCE OF SPRING MATERIALS"

By Rodman R. Tatnall, Metallurgist, Morgan Works,
Wickwire-Spencer Steel Co., Worcester, Mass.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 545)
This Paper Received the 1938 Honorable Mention for the Ferrous Division

(A talk was given by R. R. Tatnall, Engineer, Wickwire-Spencer Steel Company, Worcester, Mass.)

— Discussion —

Mr. Clifford: Gentlemen, I feel that Mr. Tatnall should be congratulated on the very able manner in which he has presented his subject. He has brought out the difference between elastic limit, resilience, endurance, and a number of these properties of springs, which to the ordinary wire drawer or layman, you might say, are more or less technical.

He has maintained a balance between the technical and the practical, all of which has made his paper very understandable. I know that our Association, which is composed so largely of practical men would benefit a great deal by more papers of this calibre.

I do not know how many here present today are concerned either in the manufacture of spring wire or in the manufacture of springs. However, I do feel that this paper has been presented in a manner that should lead to some very interesting discussions. I would like to throw the meeting open at this time for questions and discussions in connection with this paper.

Mr. Westphal: I would like to congratulate Mr. Tatnall on the fine manner in which he has presented his paper. I would also like to ask a question of him. Is resilience directly proportionate to the tensile strength of the round wire,—in other words, you have say three grades of spring wire. We will say that is made from a low carbon Basic or Bessemer—that is the first grade. The second grade is made from, we will say, medium carbon; carbon say from thirty to thirty-five to forty-five carbon and the third grade of spring wire is made from fifty to seventy carbon. Now this steel is worked into the finished spring wire! Practically speaking is not the resilience directly proportionate to the tensile strength?

Mr. Tatnall: The answer to that is: Yes, it is, with the one provision that you are putting these wires into the same kind of a job. If you apply them on the same job the resilience will be in proportion to the stress at which you can use it.

Mr. Westphal: In boiling it down to a practical understanding, you might say that the tensile strength is directly proportionate. Of course, it is assumed that the resiliency will be much less on the lowest grade of spring wire; resiliency will be a little more on the medium spring wire, and the resiliency will be greater or greatest at the highest tensile strength.

Mr. Tatnall: Yes. What you are really asking is the relation between elastic limit and the tensile strength, is it not?

Mr. Westphal: I am asking as to the tensile strength and elastic limit. Is it fair to assume that the elastic limit is between fifty-five and sixty per cent of the ultimate breaking strength on high carbon spring wire?

Mr. Tatnall: Yes, I think that ratio will hold for cold drawn wire. It may vary some; I mean the lowest analysis might be less than fifty. I don't know for sure.

Mr. Westphal: I would like to go on record as saying that I agree with the author, that tensile strength is directly proportionate with resiliency.

Mr. Timberlake: If you have a hard drawn spring wire and an oil tempered spring wire of the same analysis, and you have in those pieces the typical type of surface imperfection, such as short cracks, maybe one thousandth or two deep, when submitted to fatigue, has there been any measure made of whether the hard drawn or the oil tempered spring wire is affected most by that type of a crack in the surface, or is it proportional to the stress of the two wires?

Mr. Tatnall: Well, that is a pretty complicated thing to measure. There have been attempts, and the attempts haven't been entirely successful in correlating the nature of the scratch, I say scratch because that is what it was in one case I am thinking of, with the differences found in the fatigue endurance limit. I think your question can be definitely answered that there is a difference between a hard drawn wire and an oil tempered wire in that respect, which traces back to a difference in so-called notch sensitivity. The heat treated material has a greater degree of brittleness. I say **degree** of brittleness. I don't say the heat treated material is brittle, but there is a degree of it there and it is more sensitive to a notched condition than a hard drawn material.

But that is all involved with the manner of testing, and again this application of load is important, whether it is torsion or bending or so forth.

Mr. Timberlake: Are you willing to make any guess? 10 per cent more?

Mr. Tatnall: I wouldn't want to guess about that, and I don't know of any comparison made along that line.

Mr. DeFries: I would like to know the relation between straight compression loading and impact loading in reference to the fatigue limit. That is one question. I would also like to know whether you can tell me whether the fatigue endurance limit for hard drawn wire in relation to the ultimate tensile strength is the same percentage as it was given in the paper for oil tempered wire, which happened to be sixty-six per cent or something along that line?

Mr. Tatnall: I don't think any percentage has been definitely established, but enough tests have been run to show that the hard drawn wire will run a little lower. Just how much I don't know; it might be as much as ten per cent lower.

Mr. Clifford: Do you mean the percentage of the tensile strength to the resilience or was that elastic limit. The tensile strength and resilience would be lower in the case of hard drawn than in the case of the oil tempered wire spring. Of course, it is natural that the elastic limit would be lower.

Mr. Tatnall: Yes. It has been established for quite a long time from a lot of fatigue tests that the endurance limit in bending of various steels runs anywhere from forty percent to sixty-five or seventy per cent of the tensile strength. It has also been established quite well, in fact, the tests we have made check out between sixty and sixty-five per cent of the ultimate tensile strength on oil tempered wire. On hard drawn wire we really haven't made enough tests so I don't want to commit myself, but the tests do show a lower endurance limit in hard drawn wire than is found in heat treated wire of the same strength.

Mr. DeFries: I have another problem to be answered. What is the difference in testing between putting a fifty pound load gradually on a spring and dropping a fifty pound weight all of a sudden? In other words, if you put it on gradually you start out with one, two, three and four pounds until you have reach-

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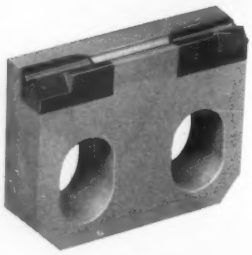

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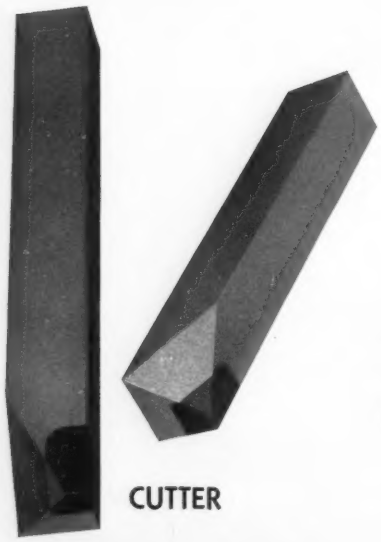
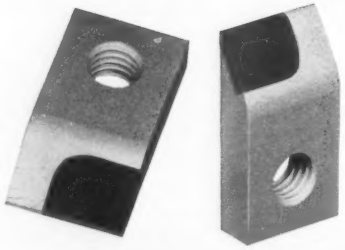


CUTTER



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McKEESPORT, PA.

ed fifty pounds. Or, in the other case, you start out with the fifty pound load suddenly released and get the impact on the spring. What difference does that make on the fibre stress in the fatigue behavior of the wire?

Mr. Tatnall: I will try my hand at being an artist for that one. Your first point was that you were going to put a certain load on the springs and you would drop it back to zero.

Mr. DeFries: Whatever the spring will take.

Mr. Tatnall: Well, start from zero and you work that spring between zero and this load and you find this point where the endurance limit occurs. In that case you don't have any cycle of loading. Take your automobile valve springs. We are in a good town for that; that works between two loads. That works between sixty-five pounds and thirty-five pounds, and let us assume that it never breaks.

It doesn't break for the simple reason that on the fatigue diagram this point, this load falls under that line. Supposing we take that same spring with sixty-five pounds, and thirty-five, and you design your engine so that spring will give you an eighty-five pound load. You are starting from thirty-five pounds and you go up here to eighty-five and that spring will break because your endurance limit line appears right in there at seventy, we will say. Now, that spring works back and forth between these loads all the time. In this case you work from thirty-five to eighty-five. If you worked from thirty-five to seventy you might break it and you might not, because there is an amount of variation that comes into it there.

Mr. DeFries: That doesn't answer my question.

Mr. Tatnall: I don't know of any relation between fatigue tests of that nature. Going back to my text book, the text book will tell you that on an impact test, such as performed there, your stress set up is twice as much as when you let the weight come down slowly. Take your spring and let the weight down onto it slowly and it will compress so far. You drop the weight on it and it will compress twice as far. This is a little bit theoretical because you can't put the load on without any time elapsing, but it would be nearly twice as much due to the impact of the load. That would affect your fatigue life. Doesn't it usually run lower on the impact test?

Mr. DeFries: Yes, it does.

Mr. Tatnall: That is because the stress is nearly twice as much.

Mr. Timberlake: Mr. DeFries, isn't there a great difference in the manner in which that load is applied besides the impact? In the one case you bring the load down uniformly on your unit, whenever you want a test, and on the others you have a various amount of types of material which might not necessarily transfer your impact load each time.

Mr. DeFries: I am just thinking about testing individual springs. There are two different loading conditions, so to speak, and what I want to find out is whether the fatigue endurance limit acting under such forces on those springs is identical for both cases or what relation there is between the forces acting on the springs?

Mr. Tatnall: I assume you have a jig that holds the weight in a position such that it never comes down offside on the spring?

Mr. DeFries: No.

Mr. Tatnall: You say you drop the load on the spring and it oscillates. You are giving that spring a variable loading cycle with one loading and then you repeat that?

Mr. DeFries: Yes.

Mr. Tatnall: Well, it goes back to the diagram. You may hit it and you get a stress way up the first time the load comes down; it doesn't come right back to zero and then it goes over here and then here. Each time it goes up and down it moves less and less and it finally stops.

You are giving it a stress from zero way up to here and then it comes down to here. I don't know if I am good enough an artist to do this, but the stress,—all these three points are over the endurance limit. Finally you settle down in here to zero motion and you get under the endurance limit. That loading won't break it but all the other oscillations contribute to the breaking. These first two affect it quite a lot because they are way over the endurance limit; they will start to crack very easily. This one perhaps won't contribute so much but you put another big one on top of it and you would expect your cycles of life to vary off and on.

Mr. DeFries: In other words, when we get beyond the so-called endurance limit stress, we can expect anything; there is no fixed life at all?

Mr. Tatnall: There is some relation. It isn't mathematical. You can't say twice as much excess over the endurance limit will break it twice as soon because it won't. In fact, this diagram is derived from another one in which you load from zero to a certain point here, and see how long it takes to break, and that is plotted out. This letter N represents the number of cycles and we plot it against the stress at which we test it. We get a point which may be fifty thousand cycles and we drop the stress down a little bit and ye get another point which may be out here at ninety thousand cycles and so on until all of a sudden we get one out here that doesn't break. We draw a line in there and where that line turns,—or, in other words, this stress value determines the endurance limit. That is the definition of endurance limit, and this relation is fairly good.

If you are not careful in your tests you might get points pretty well off from that line, but if you are really careful and have a good machine, in other words, a good test will come in a straight line and from that you might determine the life at any given stress, but it is pretty risky business.

Mr. Clifford: Who has the next question to ask Mr. Tatnall on his paper! Can anyone bring out some new point in this connection?

Mr. McCarthy: I was wondering, on this question of resilience and stiffness, what is the relation between stiffness and resilience in two wires.

What I was getting at was, that you take two wires of the same tensile strength, one Basic and one Bessemer. and it is common knowledge that the Bessemer will be stiffer in regards to reflection than the Basic wire.

Mr. Clifford: Gentlemen, I think there is a great deal in this discussion that might be of great interest to the readers of the minutes of this meeting, if we get it in such shape that the stenographer can take it down. Will you please speak distinctly? Am I right, Mr. McCarthy, in interpreting your question something like this: Assuming you have two wires of the same tensile strength, and assuming that, with wires of the same cross section you would have a greater resistance to bending with a Bessemer wire than with a Basic open hearth wire, would there be a greater resilience in the Bessemer wire than in the open hearth wire? Is that the correct interpretation of your question?

Mr. McCarthy: If everybody is willing to admit that you can get more stiffness in the bending of a Bessemer wire, I would like to know if that has any relation to the resilience, and if it has, the original remark here that the resilience is in direct proportion to the tensile would not hold true.

Mr. Westphal: Mr. Chairman, I would like to state that I believe that both Bessemer and Basic with the same physical properties and put to work and tested for resilience, that they will both be the same. Of course, I bear in mind that you have the residual phosphorous in Bessemer, but regardless of it, if you have the same tensile strength, I maintain you have or will have the same resilience.

Mr. Tatnall: I would like to get my say in here, too. I don't know an awful lot about the difference between Bessemer and Basic, but it doesn't go back to modulus, because Mr. Westphal is quite correct. If we could consider modulus the stiffness would be exactly the same.

I was going to answer your question when you first gave it that way, but I was trying to think of the softest wire I could conceive of, a hard drawn spring wire, and make a spring out of each one of those of exactly the same deflection range, but the Basic wire will not go so far before it reaches the elastic limit.

So going back to modulus there is no difference but when you speak of this gut, or whatever it is, take a piece of wire in your hands and you bend it,—and I will draw a picture of the bending. You put a little force on with your fingers and on a piece of Basic wire all of a sudden it gives, it gives easily, that is shown by this. You take a piece of Bessemer wire and it will duplicate this and it gives, but it doesn't give in the same way. You continue to build up load even though you have exceeded the elastic limit. You bend it so it stays put, but you continue to put a little more force on it in order to keep bending it, whereas the basic wire yields more. That may be a little exaggerated.

Mr. Simmons: Perhaps we have all forgotten the percentage of elongation, and I think that word tensile strength should be changed to tempered. Considering the chemical analysis plus the amount of the drafting, I think the wire of the same temper and of the same size, the endurance limit is always dependent on the percentage of elongation. Isn't that true, Mr. Tatnall?

Mr. Tatnall: On oil tempered wire you have a much higher percentage of elongation than you have on hard drawn wire.

I can't quite go along with you on that, perhaps from lack of experience, but we have had a very great difficulty in correlating physical properties with the variation in endurance limit.

Some people have said that the ultimate torsional strength determines endurance limit, but we have never been able to check that, and we have never definitely compared elongation with any figures on that. We have tried to correlate tensile strength and twist in a torsion test, but I haven't anything definite on elongation.

Mr. McCarthy: On elongation alone it would be very easy to produce a high carbon wire with a tensile strength of two hundred and eighty thousand pounds per square inch, with all the resilience and everything that goes with it, still with an elongation of say five per cent in ten inches, you can also produce a low carbon wire with probably one-third the tensile strength and one-third of the resilience and all the other properties and only about three per cent elongation.

Or you could vary the elongation over a wide range in the hard wire and, of course, over a wide range low carbon wire, but under no conditions would they react the same, as far as the resilience is concerned; still the elongation could be varied. If we include temper we all agree the thing is stiff.

Mr. Simmons: If the temper is the same it is elongation.

Mr. McCarthy: That is the point. I was thinking you wouldn't say the temper of the two hundred and eighty-five thousand pound wire would be the same as the one of one hundred thousand pounds, one having say seventy carbon. Still you can get a five per cent elongation on the two hundred and eighty-five thousand pound wire, or you can get a one and one-half per cent elongation. You can get a five per cent on the hundred thousand pound, if you heat it high enough.

Mr. Simmons: That would increase the elongation.

Mr. McCarthy: I can do that and still increase the tensile.

Mr. Clifford: Doesn't this resolve itself into how we define temper?

Mr. Simmons: Isn't a good definition of temper the chemical analysis combined with the amount of the drafting given that particular analysis?

Mr. Clifford: I think you would arrive at a certain temper by both analysis, physical work and heat treatment. However, it seems to me that you would have to arrive at what terms you are going to measure this temper in before you can compare this with resilience.

In other words, if you are going to correlate resilience and temper you would have to define how you are going to measure the temper. I don't know anything about spring but this discussion is interesting to me because I think it is important to bring out some of the relations between the other physical properties and this thing that we call resilience.

Mr. Westphal: I am going to build up a question for the author to answer. I would first like to ask him how he determines fatigue or endurance in his research paper. After he has explained that I might be able to reason with him on what my question is.

Would you mind telling us, Mr. Tatnall, how you make fatigue or endurance tests on wire?

Mr. Tatnall: There are two ways. One consists of making springs to determined dimensions and testing them a large number of cycles under different loads and finding out what springs break in connection with the load and how soon they break. There are other methods; a lot of other methods. The one we have been working with lately is the taking of a piece of wire and running it on a load and to see how long it takes to break. In that way we find out this curve that I drew there, and determine, of course, where it doesn't break. We know that is the endurance limit.

That can be taken further. Particularly in the case of springs you have to take it further and test not from a zero load to a maximum load, but from some minimum, maybe ten pounds, maybe twenty pounds, or what it should be. Ten minimum, twenty or thirty and so on and for each of those minimum loads determine the maximum load the spring will carry without breaking. It is quite a long testing procedure to establish a complete diagram for that material.

Mr. Westphal: The question I was building up to is: It is a fact that you will have more resiliency in a wire than a spring wire that has a higher fatigue, is that true?

Mr. Tatnall: Yes.

Mr. Westphal: In other words, take two wires of about the same practical physical properties. One wire will be lower in fatigue. Therefore, the wire that has the higher fatigue value or endurance limit that you determine, that with the higher fatigue will also have the higher resiliency, is that right?

Mr. Tatnall: Yes.

Mr. Westphal: I am inclined to agree with you exactly.

Mr. Tatnall: This matter of fatigue doesn't enter into every wire application. For instance, probably a good example would be a garage door. There is a big spring in there which helps you to lift the door up. Now, if you open that door and close it, I think it is seven times everyday, it will take you ten years to build up twenty-five thousand cycles; somewheres in that neighborhood. These are rough figures.

Now, in ten years your spring may rust and break, or the cables may wear out or you may sell the house. So fatigue is not a problem in that connection. On the other hand take a two hour ride out into the country in your car at a normal country riding speed at thirty-five or forty miles an hour, and you may build up some million cycles in your valve springs during that two hour ride. Fatigue is a problem there.

In other words, if your expected life of a part is only fifty thousand cycles or perhaps less or a little more, fatigue isn't a problem because other things may happen to it before the wire part may break. But where you have to have a million or two million or a billion cycles of loading in your part then you have to design for fatigue.

I think it would be safe to say that seventy-five per cent of your designed wire applications,—of that you can consider resiliency from elastic limit rather than fatigue. In the other twenty-five per cent you bring in fatigue.

Mr. Mahoney: Does the age hardening of the steel the wire is composed of cut any figure in the designing of the springs?

Mr. Westphal: I believe what Mr. Mahoney refers to is the difference of green spring wire or newly made spring wire compared with spring wire which we will say is four or five months old.

Mr. Mahoney: That is the idea.

Mr. Westphal: I think the point you are referring to is: Isn't there better resiliency in the older wire?

Mr. Mahoney: Yes. In the estimating of your spring do you take this age hardening into consideration at all?

Mr. Westphal: I am inclined to believe the older spring wire would favor a better resiliency test.

Mr. Mahoney: That is what I mean. As I say, this resiliency is something new to me. But I think, and I have found out, that age hardening cuts quite a big figure in spring wire. It should be one of the factors that should be taken into consideration in the designing of the spring. Of course, when you get down right to it there are no two wires exactly alike. That is an impossibility. Even the Creator, the man who made the world, didn't make two trees alike; didn't make two rivers alike or two hills alike. They are all trees but there is a difference. So is there a difference in every cord of wire. If you go into it very closely you will find a difference. I think you will find more difference in the high carbon than what you will in the lower carbon.

Mr. Tatnall: As far as I know, nobody has ever taken into consideration this age hardening in respect to designing. As a matter of fact, your design is based on a standard figure, such as I showed in the chart, standard elastic limit. I mentioned one hundred and sixty-five thousand in bending for tempered wire. The design is made through that.

You will get a piece of wire that is one hundred seventy-two thousand in elastic limit, and age hardening may change those figures a little bit, but the designer doesn't count on them. And, as far as I know, the effect of the age hardening is much less with the high carbon steel than it is with the low carbon.

Mr. Mahoney: You make repeated test of the wire up to its elastic limit. That won't last forever. You are going to weaken that wire the same as if you handled a piece of wire and bent it with your hands. You harden that wire; you get kinks in the wire. You don't get the same result. The wire must be absolutely free from scratches and cylindrical, and if you make repeated tests on the same piece of wire it will finally fail. And I understand, of course, that when you are designing you leave a margin there, a margin between the failure and the success.

Mr. Tatnall: I think the age hardening effect is so little it wouldn't change your margin at all.

Mr. Curtin: Mr. Tatnall, what takes place when you temper a spring?

Mr. Tatnall: I call it relief stress. I wouldn't call it age hardening, perhaps it is. But I think in order to keep the

thing separate it should have another name.

Mr. Curtin: I have noticed this: that if you take a piece of spring wire and of tensile about two hundred and fifty thousand pounds,—pulling this piece of wire between two pegs about three inches apart, you will probably get a load of one hundred and forty-five pounds. Now, if you temper that spring wire at a temperature of about five-fifty your tensile strength will go up maybe four or five thousand pounds, but the load required to pull that down between those two pegs will go up to maybe one hundred and eighty. In other words, you will increase the so-called Rockwell Test maybe twenty-five or thirty per cent with probably no increase in tensile strength. How do you account for that?

Mr. Tatnall: You have your piece of wire here and it is in a state of strain. I don't recall the reference now, but somebody set out to study that strain, and they put the wire on a grinding machine and very carefully ground off a part of it and the wire curled, which means curled all by itself. This means there is a stress in there. A tension on one side, and compression on the other side, which grinding left unbalanced, resulting in the curling.

Now, you go to bend that wire and it is all ready, let's say, stressed equivalent to fifteen thousand pounds per square inch. You go to bend it and you add a certain load; add more stress and you build it up, and soon it gets to the elastic limit. I don't know how far you would pull it; you pull it to a certain point, and it reaches its elastic limit going through there and bends in.

You reach that elastic limit under a load of one hundred and forty-five lbs, I think you said, and after you have tempered the wire you have removed this fifteen thousand you have in there to begin with, so it takes an additional forty pounds to complete that closing up to get it through. There is that much more capacity for work in the material because you have taken out the stress which is left there by the cold work. That is the same thing that happens in springs. You temper them and you take out that stress and leave that much more available for doing work.

It looks as if you have increased the elastic limit. You don't in this tempering thing. You bring the elastic limit back to where it should be by removing the stress you left in there by the cold forming or cold work.

Mr. Mahoney: Do you do the same thing in the cold heading?

Mr. Beeson: I suppose you could consider a lock washer a spring?

Mr. Tatnall: Yes.

Mr. Beeson: When you form your own washer and heat treat it the washer tends to spring apart. When you form it out of a wire made on a Turk's head and heat treat it, it goes together. Why is that?

Mr. Tatnall: That is simply due to the nature of the stress you left in there, I think. In the one case it may be tension at a certain point in the wire, and in the other case the tension may be in some other point or it may be compression, I don't know the nature of the stress. But it is the difference in the nature of the stress, and the stress that is left is one thing for drawing through a die, and another for the compression rolling of a Turk's head. It is probably the location of the stress which is left there by that cold work that affects this reaction to heat.

Mr. Clifford: That might be a good subject for somebody to do a little research work on, because drawing through a Turk's head is a combination of drawing and rolling, so that naturally the forces that are set up in that wire would be considerably different from either straight drawing or straight rolling. So I think that you could expect a different reaction after heat treating.

There is one thing I think might be cleared up just a little bit here. Mr. Mahoney asked the question a while ago about age hardening and he gave the example, I think, of having been told that if a piece of wire were allowed to lie around awhile, it would become more resilient. Is that it?

Mr. Mahoney: It would work better.

Mr. Clifford: It would be less brittle?

Mr. Mahoney: Yes.

Mr. Clifford: Now, isn't that a case possibly of hydrogen embrittlement rather than age hardening? I think in most cases with high carbons and Bessemer wires, that that is an old cure that used to be used in the wire mills. If a wire wouldn't work, let it lie around a while, and the theory was that the hydrogen would escape and the wire would then be workable. Age hardening, on the other hand, I believe, is the lessening of the workability of either wire or any other kind of steel, after having been deformed through hot or cold work.

We have that notably in sheets for the automotive industry are used for deep drawing operations. These sheets, after being processed in the mills, if allowed to lie around very long, do age harden, and in order to reproduce the workability of those sheets, they are put through what is commonly called a roller leveling operation.

In other words, they are alternately stressed in opposing directions and that seems to remove this age hardening effect. Now there is no doubt that the same kind of a condition would exist in wire. Would anyone like to tell us anything more about age hardening?

Mr. McCarthy: I couldn't tell you all about age hardening, but the age hardening is precipitation, and in low carbon is particularly noticeable because a small amount of the carbon goes into the solution on cold work and precipitates out again.

It is much more noticeable in low carbon than in high carbon. This other comment that Mr. Mahoney noted followed more along the line of stress rather than age hardening. I don't think it is strictly age hardening when you take a wire and temper it and get that increase in tensile and so on; I don't think that is in the same category as age hardening. Age hardening in the sense we generally consider it, is usually precipitation. Precipitation of some constituent, and in this case it is the carbon.

Mr. Clifford: There were a couple of simple questions that I wanted to ask, but I don't think they add much to this discussion. In a couple of your diagrams, where you showed the wire sull coated at one end and at the other end, at one inch distance, a weight which produced a torsion, was the wire supported at this point also so you didn't have a combination of bending and torsion?

Mr. Tatnall: You are quite correct, it was not shown supported. On the diagram as shown I would have a combination of bending and torsion but calculations are for pure torsion. I simply drew that to illustrate the example of torsion. I was perhaps at fault in not pointing that out.

Mr. Clifford: Now, another thing that I wanted to ask. You had another chart there in which you showed a square versus a round wire, and showed a difference in the amount of deflection with an equal amount of weight. Were those wires of the same cross sectional area or of the same diameter?

Mr. Tatnall: The same dimension.

Mr. Clifford: In that case you would expect less deflection with a square wire because it would have greater cross sectional area?

Mr. Tatnall: There is an additional difference.

Mr. Clifford: There is the additional difference of the distribution of the material constituting the wires in relation to the central axis. Maybe you can explain that a little more thoroughly? I didn't quite understand the comparison between the square and the round wire, if they were not of the same cross sectional area.

Mr. Tatnall: That all comes from the formulas I showed in that chart and I didn't go into the derivation of those formulas at all, because after 10 years out of college I've forgotten most of my higher mathematics.

But it arises from the fact that both stress and motion formulas depend upon the distance from the center, the technical term is neutral axis. The point in the cross section where there is no stress, as in the case of torsion,—you are probably all familiar with the fact that you twist a wire and twist it and in the very center there is no twisting action, but away from the center there is, of course.

In square wire it is the distance from the center to the corner, not half the dimension here, but the distance from the center to the corner, which is half the dimension multiplied by the square root of two. In other words, this length is forty per cent greater in square than in round on the same dimension.

Therefore in square wire you get a higher load capacity or for the same load you get lower motion. It arises from the formula, and not from the fact that there is a difference in the cross sectional area.

Mr. Clifford: Gentlemen, I am sorry to cut this discussion short because of the fact that there have been so many interesting points brought out here, but the non-ferrous section has asked us to announce here that they have an interesting picture showing in the Colonial room. It may be finished by this time, as they said they were going to start about four o'clock.

However, if they are still in session you may be interested in seeing what is left of that.

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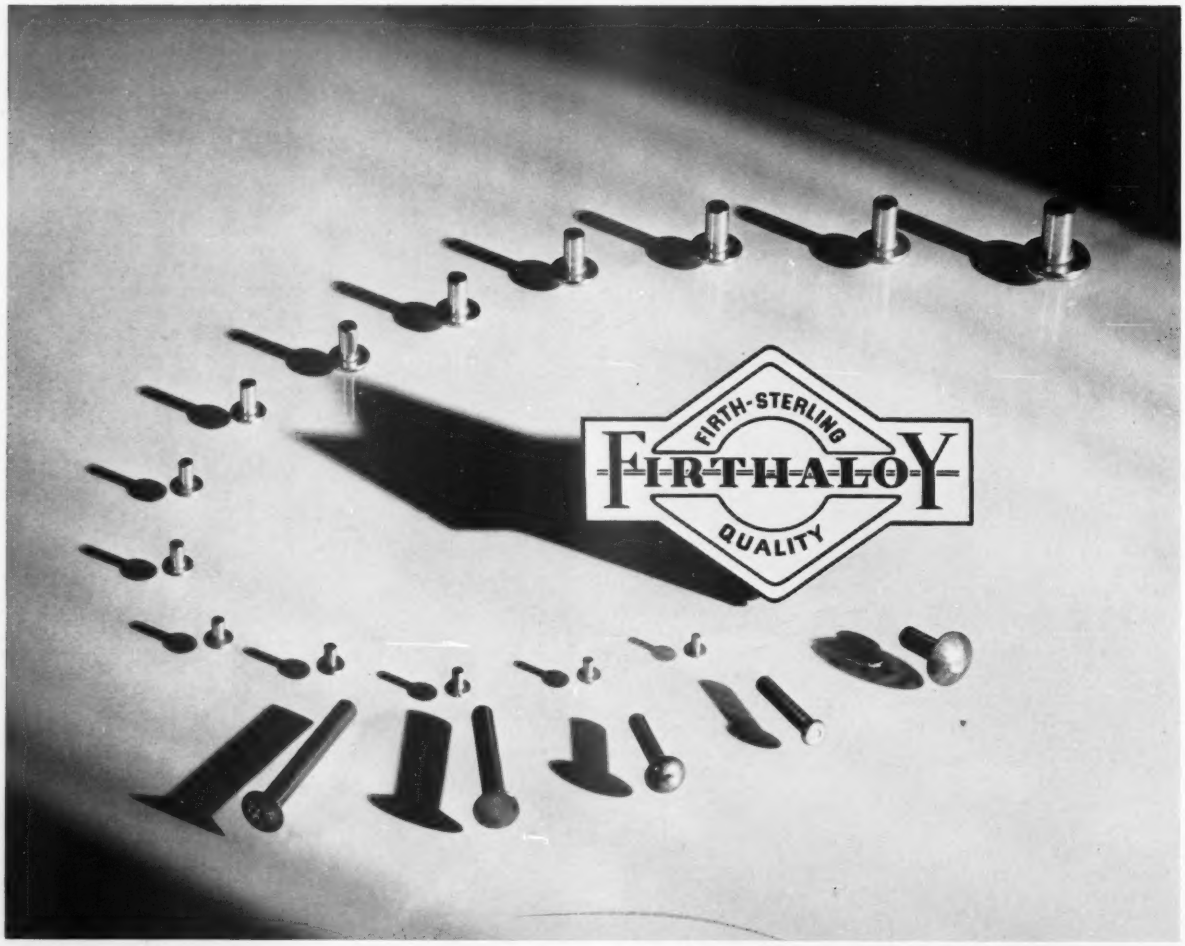

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FERROUS DIVISION

Meeting, Tuesday, October 18, 1938 - 2:30 P. M.

Chairman of Meeting

M. A. Reeder, Metallurgist,
Jones & Laughlin Steel Corp., Pittsburgh, Pa.

PAPER: "THE EFFECT OF UNDER CRITICAL ANNEALING TREATMENTS ON COLD DRAWN CARBON AND ALLOY STEELS"

By F. C. Brandon, Metallurgist,
Union Drawn Steel Div., Republic Steel Corp, Massillon, Ohio

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 531)

Mr. Reeder: It looks to me as though we have two very good papers on the program for this afternoon. Both of which will be of special interest to the Wire people, and there should be a lot of good discussion. And without much further ado I will call the first speaker, who is Mr. F. C. Brandon, of the Republic Steel Corporation, who will speak on the subject, "Effect of under critical annealing treatments on cold drawn steels."

(Whereupon a paper was read by Mr. F. C. Brandon, of the Republic Steel Corporation, on "Effect of Under Critical Annealing Treatments on Cold Drawn Steels.")

— Discussion —

Mr. Reeder: This meeting is now open for discussion. There must be quite a few questions in line with the subject matter that Mr. Brandon has given us along the line of wire problems, that we will be interested in and having Mr. Brandon answer them for us. So anyone having a question please give your name with the question.

I would like to ask a question. Did you run into grain growth on some of these temperatures in your under critical annealing that might affect some of the results that you have gotten?

Mr. Brandon: There is no doubt that there was some grain growth, particularly at the 400 degree crystallization period, but we were unable to determine that miscroscopically. It would probably show up on an X-ray analysis, but through the miscroscope we were unable to determine any appreciable grain growth that we could honestly charge to the low temperature in the annealing treatments.

You see, we are not giving as heavy a draft in the bar industry as the wire industry experiences as their normal condition from what I understand. Our maximum draft is generally in the neighborhood of 16 per cent reduction, and with a reduction such as that we do not get the decided grain distortion that would result from heavier drafts.

Mr. Lewis: Has it struck you that the effects that you got from these low temperature anneals, are very much like ordinary aging effects. Do you notice any difference between them, any trend that they may show that the difference from the trend in ordinary aging?

Mr. Brandon: That is a difficult question to answer, as we have not had an opportunity at the present time to determine just exactly what the aging effect of these materials might be.

I might say that we have duplicates of all of these tests on hand, which we intend to age at normal room temperature for a period of at least a year and then duplicate the annealing tests. The only point that came out that would indicate definitely that this has an aging effect is the return of the jagged stress strain curve on the yield point and that material which has been given to low temperature anneal, or the drop of the beam on the tensile machine. I don't think there is much doubt but what it has accelerated aging.

Mr. Lewis: I have been checking your results against some work done by Dr. Brown some years ago at The Glasgow University. His work was done under somewhat similar conditions, that is drawing was done at a low speed on testing machines with short pieces, and it was all bar work. The reductions ranged all the way from the extremely low reductions, which are commonplace in your branch of the industry, up to reductions such as we wire men consider normal, 30, 40, 45, and he even was able to draw bars up to 55 per cent reduction, by taking extreme care. He ran the most elaborate set of tests on those bars over a period of nearly a year. He began testing about an hour after the draft. He tested at 24 hours, a week, then a month, and the final test was all the way from 9 to 11 months. And it struck me rather forcibly, of course it is not easy to correlate two researches of this sort, in fact, it is not easy to correlate part of one research with another part, but it struck me very forcibly when I compared the two in the last few days, that up to a matter of about four or five hundred degrees you were getting just exactly what Dr. Brown got, but you were getting it right now instead of next year. I don't mean to disparage the research and the value of its result, because after all, bars that you draw and sell are probably going into production a long time before anything like the ultimate in aging is reached, and if you can get an aging effect in a few hours,—if you can do a year's aging in a few hours, so much the better. I just wondered if it struck you people that up to four or five hundred degrees there was practically nothing but an accelerating aging.

Mr. Brandon: It has struck us that way. Unfortunately I am not familiar with the paper to which you refer, but I would like to know if during that period he got a decided drop in the yield point. Do you recall?

Mr. Lewis: No, I do not. That surprised me in your work. I wasn't looking for that. That tremendous dip in the yield point at about 350 to 400 degrees was a little shock to me, I don't think Dr. Brown got anything of the sort.

Mr. Brandon: I think I could say it was a bit of a shock to us because we didn't expect it either. As I say, it must be re-crystallized because the tensile remains the same, and after all

a tensile test is in effect cold working. After the yield point is passed you get a cold working test effect. That would tend to hold the tensile on a fairly even curve. The fact that we got that dip at 400 in two different steels indicates that it is evidently something that we have not known about and it may have its uses, I don't know at the present time. I might say that practically all of the work we have done, commercially, using this method of treatment has been in excess of 700 degrees in order to take advantage of the higher impacts of properties that are available from that temperature on.

Mr. Lewis: Another thing I would like to ask is: These properties secured by annealing temperatures, are they stable or does natural aging continue after your accelerated aging? For instance, that tremendous dip in the yield curve, is that stable, does that condition stay with you on further natural aging?

Mr. Brandon: There is evidently additional aging, as indicated by the brinells made on the impact specimens, as compared to the brinells made on the tensile specimens. Those brinell curves were not always in accord, although they followed the same general trend. The additional aging I would say is beneficial rather than detrimental on the basis that the brinell curves are made from the impact specimens,—they are more uniform and more even than those made on the impact specimens. With your reference to your statement about the loss of yield, we find that the brinell curves made,—I won't call for the slide again, but brinell curves made on the X-1325, on the tensile dropped to 256 from 270, the brinell curve made on the impact test dropped from 282 to 260 at 400 degrees and then went back to 282.

Of course, that was only a period of about two weeks. But that is evidently stable for that period of time, over a period of time we are simply not able to say at the moment.

Mr. Lewis: For the purpose of this experiment did you draw the bars for this?

Mr. Brandon: We used our own. We used, as far as possible, our normal cold drawing practice because after all that is what we were after, we wanted to know just what this would do under normal operating conditions.

Mr. Reeder: I would like to ask a question: Do you find quite a little variation from heat to heat on the physical properties?

Mr. Brandon: I think we do. It is that variation from heat to heat that is probably going to eliminate the possibility of using this material for any places where close hardness tolerances are required. I doubt very much if this practice could be adapted to a part, that is to be heat treated on—let us say to three Rockwell numbers as the maximum spread. I feel confident we could meet a range of six to seven brinell numbers or work to a minimum hardness. But there is a certain amount of the variation that is tied up with the hot roll structure, the method of deoxidation and the rolled grain size, and the McQuaid-Ehn. We have those four factors we must take into consideration.

Mr. Reeder: Which grain size would you find the greater variation,—fine or coarse?

Mr. Brandon: Coarse, I should believe. Coarse would always, on the basis of these tests, give lower impact by less ductility, which is what one would expect, I believe.

Chairman Reeder: Are there any more questions? The next speaker is Mr. Hopkins, Metallurgist of the National Screw & Manufacturing Company, Cleveland, Ohio. His talk will be on "Some Characteristics of Wire and Their Relation to Cold Heading."

Meeting, Tuesday, October 18, 1938 - 2:30 P. M.

PAPER: "SOME CHARACTERISTICS OF WIRE AND THEIR RELATION TO COLD HEADING"

By H. L. Hopkins, Metallurgist,
The National Screw & Mfg. Company,
Cleveland, Ohio

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 521)

(A paper was read by H. L. Hopkins, of the National Screw & Manufacturing Company, Cleveland, Ohio, on "Some Characteristics of Wire and Their Relation to Cold Heading.")

— Discussion —

Chairman Reeder: We have listened to a very interesting talk as it concerns both the wire and bolt manufacturers, and I know there are questions they would like to have cleared up in this case. The meeting is now open for discussion.

Mr. Hopkins: There are just a few comments regarding grain growth that I would like to add to my paper.

By drawing the material beyond the point of critical strain, the range in temperature which will produce grain growth is materially decreased. Subsequent cold heading operations also tend to overstrain the metal and the resulting headed blanks will show very little tendency toward grain growth and in any event, the temperature range will be exceedingly small. By heating the material away from the critical temperature, no difficulty should be encountered with grain growth. Material to be heat treated near the critical temperature should be cold worked either on the draw bench or in the headers to sufficiently over-strain the metal, so that grain growth will not occur.

Low carbon wire can be cold headed after considerable reduction. As a result, it is very easy to completely eliminate the error of grain growth on subsequent heat treatments. Fortunately the higher carbon material does not require the excessive cold work that low carbon steel requires, and as a result, it is also possible to control conditions to eliminate grain growth in cap screws, bolts, rivets, specials, etc.

There has been an interesting contribution to the subject of grain growth since this paper was prepared. A series of three articles appeared in recent issues of our magazine "Wire and Wire Products" by Mr. R. W. Sandelin on the subject "Factors Affecting Grain Growth in Annealed Rivets." His summary includes "The strain existing in a rivet is a function of the amount of drafting upon the wire." This being the case, it is possible to adjust the amount of cold working to a degree where no grain coarsening will occur in subsequent commercial annealing operations." His observations appear to check rather closely with those mentioned above.

In conclusion I might add that close cooperation between the wire mill, headers and heat treat department can be so adjusted that very little fear of grain growth will be experienced. Bolt plants which are not equipped to do their own wire drawing are at a slight disadvantage. They can overcome this by working in conjunction with the supplier to arrive at the proper wire temper to obtain the most advantageous balance in material. By this cooperation, the fear of encountering detrimental grain growth can be held to a minimum.

Mr. Dove: I was interested in Mr. Hopkins' paper on cold heading particularly in the part connected with the discussion of the preparation of the rod. I notice that you stated there that sull coating is more or less out of the question. Well, what do you apply in the place of sull coating? Is there an air coating, there, I mean?

Mr. Hopkins: I don't mean to infer that sull coating is out of the question at all plants. I mean, that sull coating is out of the question at the plant of The National Screw & Manufacturing Company. We have a finish which the header operators, header foremen and operating control department feel is superior to the sull coating. As a matter of fact, we feel that it is superior to anything we have ever tried. If we discovered a coating that was better than what we have, I believe we would perform necessary investigations to find out why, and adopt it, if the coating proved superior.

Mr. Mahoney: I would like to ask if that produces a white wire, your coating, a little colored wire. The reason I ask that is because I saw at the exhibition some white, and I also saw some

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sull coated, very well coated indeed. I do cold heading both in wood screws, machine bolts, and nails. I have found sull coating very satisfactory if properly sull coated.

Mr. Hopkins: I think I had an opportunity of looking at the wire you referred to, and I may say in both cases it looked very nice. That was very good wire.

Mr. Mahoney: And another thing, in going around I have spoken to some workmen, some elder men and they say they want the light wire, no coating on it at all practically. So I asked the man, "Do you not find this very difficult on your dies?" "Doesn't it wear them out very quickly with no cushion between them at all?" He said "We use a lead mixed with oil and the oil goes through that." Is there anything to that?

Mr. Hopkins: In completing the answer to your first question, the finish described in the paper is very similar in appearance to the light or white finish you saw at the show. I don't know exactly what their finish is made from, but it does look like the finish we produce.

In reply to your second question there is as much difference in operation technique between header operators as there is between day and night. One header operator on a bank of machines will use wire as delivered from the wire mill. Another operator on the next battery of headers will cover the same wire with white lead and oil. It is very difficult to prevent it, because he thinks he can do a better job. This is particularly true of the older header operators, who encountered a great deal of trouble with wire finishes in the past.

Mr. Coppick: In connection with the special jobs, have you ever run into a heading operation that would require a wire, say of the following characteristics: Restrung, light lime and a heavy sull coat, and if you did require that in the specification did you get that?

Mr. Hopkins: I don't believe I am in a position to answer your question. If there is anyone in the audience that could, I would be only to glad to have them offer a suggestion on this subject. However, we have tried a large amount of the sull coated wire from different sources.

Mr. Coppick: Grease drawn heavy sull coated wire?

Mr. Hopkins: I am not in a position to comment on that. I don't pretend to be an expert in all fields of cold heading. If there is anyone that is, he is an exceptional man.

Mr. Seymour: To help you out on the heading problem, I think the ideal condition is to have as thin a coating on the wire as possible and still have the lubricating quality for the solid die. Where there is a little chance of lime caking, as you showed on your slide, the sull coat does help the die considerably. When you start getting into the single and double extrusion process you have to eliminate any possibility of your coating being wiped off in the die. So sull coating is more or less ruled out because it is built up on the surface of a wire and will scrape off and fall into the crevices of the die. A lime stearate mixture seems to draw into the skin of the steel which gives you a hard coating which doesn't scrape off. As far as the die is concerned, the die life would probably be increased with the sull coat, but you have the disadvantage of it being scraped off, so we have to count that off in favor of maybe not such a good die life, but the fact that all blanks are perfect.

Chairman Reeder: I think there is one point that might be expanded on somewhat in connection with the cold heading wire. That is, I was particularly interested in the chart on physical properties, and in connection with that, is the use of the smaller gauges of cold heading wire,—we are limited, of course, on our cold heading rod size, which is the No. 5 rod, or about .218 in diameter, and in the application of smaller gauges of wire, that is where you get down to three-sixteenths or smaller, your physicals are going to increase materially for the same chemical analysis because of the extra number of drafts and resultant excessive cold work. Do you mind elucidating on that point?

Mr. Hopkins: In the case of small wire sizes to be drawn from No. 5 rod, certain precautionary measures must be taken to keep the physical properties of the wire low enough to give sufficient header efficiency to warrant running the job. If the physical properties become too high because of the excessive cold work, it is necessary to process the wire by giving an intermediate anneal. This is accomplished by drawing the rod to wire, annealing and then drafting to the finished size.

Chairman Reeder: Yes.

Mr. Hopkins: Yes, you have to be very careful in the small sizes. We go down in 1/8 inch headers, to as low as .080, and that wire must be handled rather carefully.

Mr. Armour: Have you any scheduled procedure in cold heading problems, whereby not only do you consider the head diameter as against the wire diameter, but have you established any thickness ratio, as to when you will do a job with direct drawing or process wire? Or do you go, as far as you can with direct drawing, and when it starts to break, do you have to use processing?

Mr. Hopkins: Through experience along that line and by carefully studying the job in question, we have built up sufficient information, so that, it is not difficult to tell if regular drawn or processed wire is required. However, I am not in a position to mention any rule or law that governs the case. In any event, it is a mechanical as well as a metallurgical problem. Die design and blank tolerances frequently enter the picture.

Mr. Timberlake: You would state you have worked up formulas that you are using now?

Mr. Hopkins: They are not hard fast formulas, but they are based on what we have been able to do in the past on jobs of a similar nature.

Mr. Mahoney: I would state, is it not a general rule, that 30 carbon wire and higher, that the rod must be normalized before any work is put on it?

Mr. Hopkins: That is not entirely necessary.

Mr. Mahoney: But, it is generally known in the business. See Manufacturers Standard Specification for cold heading quality hot rolled carbon steel wire rods in coils—Grade 30 C. H.

Mr. Hopkins: In most cases a 30 or higher carbon steel is normalized or spheroidized. I don't know if I would interject the word "must" because I believe it could be headed without an annealing operation.

Mr. Curtin: What limits do you have on decarburization? Do you have any limits on that?

Mr. Hopkins: People in the bolt business are governed by the limit required by their customers. We do the best job that we know how. I think I am safe in saying that our men in the bolt industry are faced with that same problem, but I can truthfully say that in the past three years we have never rejected a lot of material because of excessive decarburization.

Mr. Curtin: When you buy wire do you have any specified decarburization, at which you buy it?

Mr. Hopkins: Over 99 per cent of our material is rod. When we purchase wire we usually try and have the supplier hold the decarburization in high carbon wire as low as possible. Is that sufficient?

Mr. Curtin: I was curious, as to what your specifications were. I have seen others. Have you any actual figures that you would take? Mr. Harvey has made the statement that .0005 completes decarburization on a half inch wire.

Mr. Hopkins: There is a limit to the decarburization that can be obtained. Steel wire suppliers, as a rule, will not guarantee to hold decarburization below .005". Less than .005" decarburization can be specified, but if sufficient checks are made on the material, it will probably be found that the restricted specifications are not being fulfilled.

Mr. Curtin: Have you ever made any findings as to the difference between spheroidized and normalized, as to the die lines?

Mr. Hopkins: I might say that a test has been performed on a matter of 10 to 20 tons of material, but that is insufficient to give reliable information, as to a relative comparison of spheroidized vs. normalized wire.

Chairman Reeder: Are there any more questions?

Mr. Curtin: I would like to ask a question. Have you found that a slight amount of decarburization can be an aid in cold heading to act as a soft cushion on the outside to prevent splitting and to prevent the bar from starting to open up?

Mr. Hopkins: We know that a low carbon skin is an advantage to cold heading. That is the reason that on certain difficult jobs, we resorted to rimmed steel. The carbon is extremely low in the case. The same conditions should apply to a steel that is not rimmed. A good high grade steel should be as uniform as possible. I would rather have a little more trouble with my headers and less trouble with decarburization on SAE .1035 steel than to take any sort of chances on skin decarburization.

Chairman Reeder: There is one point that I would like to ask you Mr. Hopkins. For your double extrusions, for instance, the material will naturally harden up with each extrusion. Do you notice a greater die wear as the material hardens up from one extrusion to the other?

Mr. Hopkins: There is perceptible hardening in the first extrusion operation and the second extrusion depends so much on the first that great care must be exercised in both operations. It is suspected that the first extrusion die is as important to the second extrusion process, as the original wire finish is to a single extrusion operation. There are so many factors that enter into the double extrusion work, that I am not in a position to accurately judge them all at this time; that is a subject in itself. It is very difficult to put your finger on the thing that is the most influencing to the success of that process.

Mr. Mahoney: I would like to ask you if you use a carboloy or a steel die? Do you find the carboloy extrusion die better?

Mr. Hopkins: We have found that carboloy extrusion dies, when properly made, give considerably better service than steel dies.

Mr. Mahoney: It all depends on the angle of the extrusion die.

Mr. Hopkins: It must be a well made die. The working surface must be very accurately controlled.

Mr. Mahoney: The more you polish it the better results you get.

Chairman Reeder: Are there any more questions?

(Adjourned).

Meeting, Tuesday, October 18, 1938 - 9:30 A. M.

Chairman of Meeting
L. D. Granger, Treasurer,
American Wire Fabrics Corp., New York, N. Y.

PAPER: "WIRE CLOTH, ITS MANY KINDS AND USES"

By R. B. Roth, Purchasing Agent,
Ludlow-Saylor Wire Co., St. Louis, Mo.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 559)

Mr. Granger: I am certain that many of us in the steel business are not aware of the great part which woven wire cloth plays in our industry, and also in manufacturing in general. Mr. Roth, representing one of the leading companies in his line, is, I am sure, well qualified to enlighten us along these lines, and it gives me great pleasure to introduce him to you.

(A talk was given by R. B. Roth, Purchasing Agent, Ludlow-Saylor Wire Company, St. Louis, Missouri.)

— Discussion —

Mr. Granger: I am sure that everybody that manufactures wire has had experience in selling wire to wire weavers, and there should be a few questions asked of Mr. Roth.

Mr. McCarthy: I have a question. I am not very familiar with this but I understand there is on the market some wire-cloth, where the openings are smaller than the diameter of the wires from which it is made.

I don't know much about wire cloth but I am just wondering what kind of a set up they could make to weave cloth out of wire and have the openings smaller than the wire diameter.

Mr. Roth: I would like to see it.

Mr. McCarthy: There is such a cloth on the market.

Mr. Roth: I have never seen it.

Mr. McCarthy: Well, I understand there is some on the market that has a smaller opening than the diameter of the wire.

Mr. Roth: You may have in mind the question of the twilled wire cloth, where several wires have a very fine diameter. The wires are twilled or stranded together. The actual size of one wire there is smaller than the opening, but the combined diameter of the several wires are stranded.

Mr. Vossberg: I think I have heard about it; I don't know whether it is practical or not. I understand they make the cloth out of a certain material and electroplate it.

Mr. McCarthy: I have never seen any of this cloth myself.

Mr. Galloway: That kind of cloth is sold. I think the Ludlow-Saylor Wire Company actually make some of it themselves.

Mr. Roth: Before I came into the meeting one of the members stopped me outside and asked me if I would explain the difference in the crimps, and he has evidently seen the cuts in the catalogue and brought up the question about intermediate crimp and what is meant by intermediate crimp.

For the benefit of this gentleman here, I don't know his name, intermediate crimp is a wire cloth where the opening is considerably larger than the average and in order to stiffen the wire cloth so it should not rake, an extra crimp is put in between the meshes and that is what is known as intermediate crimp.

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ACID DISPOSAL SYMPOSIUM

General Meeting, Wednesday, October 19, 1938 - 9:30 A. M.

Chairman of Meeting
E. H. Thomas, Superintendent,
George W. Prentiss Co., Holyoke, Mass.

PAPER: "MODERN PICKLE LIQUOR RECOVERY"

By Dr. N. Titlestad, Chemical Engineer,
and S. F. Spangler, Chemical Engineer,
Chemical Construction Corp., New York City

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 585)

Chairman Thomas: The subject which we are to consider now is one of widespread interest, and the Federal as well as the State authorities are getting pretty hot on this subject, because of the stream pollution.

Without any further ado, I would like to introduce Mr. Samuel F. Spangler.

(Mr. S. F. Spangler then read a paper on "Modern Pickle Liquor Recovery.")

— Discussion —

Chairman Thomas: Anyone having any questions to ask, please give their name and the question.

Mr. Lamont: What impurities did you have in mind particularly when you mentioned impurities that could be re-used without harm?

Mr. Spangler: Unfortunately, I am not a steel expert, and I don't know what impurities can be re-used. We have been told by some steel companies that they are satisfied to use pickle liquor if the ferrous sulphate is removed, regardless of what is present in it. Others tell us that there are enough impurities in the pickle liquor after crystallization of the sulphates, to interfere with satisfactory pickle operation. Now, in those conditions, we feel that the free acid must be destroyed and all controverted back to new acid. You understand that certain inhibitors stay in the solution, and they will gradually build up if you recycle the liquor, whereas, in a process involving both neutralization and roasting, all the inhibitors are destroyed and what comes back to you is the fresh acid, the same as you would buy from a chemical company using ore as a raw material.

Mr. Klein: How will a slight concentration of nitric and hydrofluoric acid interfere with your process? Are they harmful?

Mr. Spangler: The process of decomposition of the ferrous sulphate for the production of acid involves roasting the ferrous sulphate to give off sulphur dioxide gas. If you had any chlorides, nitrates, or fluorides present, you would also liberate the corresponding acids, hydrochloric, nitric, and hydrofluoric. The mixture of those acids with the SO2 gas would very probably upset the acid plant operation.

In other words, if you are pickling with any acid outside of sulphuric, the pickle liquors from those vats should be kept separate and not run through the sulphuric acid plant. It is very difficult to find suitable equipment for resisting those acids that will also resist sulphuric acid.

Mr. Long: I notice that you prefer to have Pyrites along with the coal as a reducing agent. Does that have some reducing effect, or is that only to insure a sufficiently high gas to operate a plant without auxiliary heat?

Mr. Spangler: Neither. Even the best process does not run at one hundred per cent efficiency, so if you are going to make sulphuric acid from a waste by-product such as ferrous sulphate, you might as well make the total amount of acid you need at the same time. In the phrase "The Pyrites make-up", the word "make-up" means the material required to make up the additional amount of acid that is lost in the entire process, not only in the recovery process, but in the treating.

In other words, the treatment is the same for roasting Pyrites as for ferrous sulphate, and if you put in an acid plant the equipment should be large enough to permit the burning of the Pyrites also. On the other hand, the Pyrites can take the place of the pulverized coal as a reducing agent. If ferrous sulphite is decomposed by heat without the presence of a reducing agent, you will get a mixture of SO_2 gas and SO_3 gas. You do not want that mixture in the contact process. This roast must therefore be run under reducing conditions. In the ordinary plant, the reducing material that is used is pulverized coal.

Mr. Braley: What about hydrochloric and nitric and acids other than sulphuric acid, because this is a complete acid disposal problem, which does not only include sulphuric?

Mr. Spangler: This particular process only includes sulphuric. We would recommend keeping the hydrochloric and nitric pickle waste separate from the sulphuric. If they run to any quantity, it is possible to recover the corresponding iron salts and they could be utilized. At present, the biggest problem seems to be the ferrous sulphate from the quantity standpoint, and for a good while we think there could be a market found for the iron chloride and iron nitrate as long as they are not mixed with the ferrous sulphate.

Chairman Thomas: Mr. McCarthy has made a good suggestion. As there are other men to be heard from, perhaps it might be well to hear what they all have to say, and then confine it to a question and answer period.

PAPER: "DISPOSAL OF WASTE PICKLE LIQUOR"

By Dr. Otto Mantius, Consulting Engineer,
National Lead Co., (Acid Recovery Dept.)
New York City

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 591)

INFORMAL TALK: "THE BUTLER-LITTLE PROCESS"

By J. M. Avery, Engineer,
The Arthur D. Little Co., Cambridge, Mass.
(This Paper Was Not Available for Publication)

(Dr. Otto Mantius then read a paper entitled "The Disposal of Waste Pickle Liquor.")

(No discussion followed the reading of this paper).

Chairman Thomas: The next speaker will be Mr. Avery, of the Arthur D. Little Company, on the Butler-Little Process.

* * *

(Mr. Avery then gave an informal talk on the "Butler-Little Process.")

(No discussion followed the reading of this paper).

* * *

Chairman Thomas: The fourth speaker will be Mr. Linn, of the Green Engineering Company, who will speak on "The New Method of Disposing Pickle Liquor."

(Mr. Linn then read above mentioned paper).

(No discussion followed the reading of this paper.)

— Discussion —

Chairman Thomas: The meeting is now open for your questions, gentlemen. I think we can expedite this if you would address your questions to the particular speaker.

Mr. Eppelsheimer: Mr. Chairman, I just wanted to make this statement to the gentlemen here who are interested principally in wire, because there are, of course, other sections in the steel industry that have the pickling problem.

We have been working on this particular thing for about twenty-five years, and I guess everybody else has, too, for pretty near the same length of time; but we find that there is a little bit of misapprehension among the operating men, for this reason: That they do not include the cost of disposal with the cost of the pickling. In other words, your cost of pickling should include the cost of disposal.

Now, that was perhaps a relic of times when the legislative authorities were not so active in requiring that plants producing pickle liquor make the discharge innocuous to the streams. However, that question is getting increasingly great, and all the steel industries that do pickling are faced with large expenditures.

Mr. Avery has explained one process, and Mr. Mantius has endeavored to cover the thing in a rather broad field, but after all, whatever the method is, it will be purely a question of "How much does it cost, not only for pickling but for disposal?" In other words, the disposal cost, whether it would be through ferrous sulphate or making acid at the plant, or perhaps making ferrous sulphate in the monohydrate and shipping it to the acid plant, or making it into sulphur, would depend on a great many local conditions, and the answer would come in setting up the figures as to whatever the financial cost is.

Dr. Mantius: I agree with Mr. Avery and Mr. Eppelsheimer that the cost of recovery or disposal must be charged to the pickling process. We have always pointed out to our customers that it is necessary to adjust the pickling operation to the recovery process in order to obtain the lowest continued operating cost.

Without recovery of the free acid it is probably advisable to exhaust the pickling bath to a free acidity of 2% or 3% H_2SO_4 as this method will decrease the cost of neutralization but pickling acid of this strength is very inefficient and the output of such a pickler is greatly reduced. In our process the free acid can be recovered at reasonable cost and the combined cost of the pickling and recovery operation could be greatly reduced if a minimum acid strength of about 5% is maintained in the pickler. In such a case the output of a pickling vat could probably be doubled and additional savings could be made by allowing more time for letting the adherent acid drip back into the tank, which otherwise will be absorbed by the washwater and must be neutralized.

Prof. Hodge: In studying this problem of this particular treatment disposal which can be used, there is a lack of any comparative costs of the different processes, although some of them give estimated costs for installing a plant that will handle ten thousand gallons of pickling liquor a day, I was wondering whether any of the speakers could give us any estimate as to the cost of their process as to per ton of steel, or to some unit, that they produce. I think that is what the average steel man would like to know,—how much per ton of steel that they produce does it cost?

I think Dr. Mantius mentioned that the sulphuric acid would cost, by this process that he described, $3.00 more per ton,—no, it would save $3.00 per ton for acid that has been made from ferrous sulphate. How would that cost compare with the sulphuric acid as made from the sulphur itself?

Dr. Mantius: Regarding the first question of Professor Hodge, the cost of pickling depends largely on the amount of acid used per ton of steel and the steel mills have given us figures varying from 40# to 80# per ton of steel. Assuming an average of 60# and the cost of 60° acid as $12 per ton the cost of the acid used for pickling will be 36c per ton of steel, to which must be added the cost of steam, power and labor.

The cost of recovering the free acid from the pickle liquor depends on the amount of acid used and the quantity of free acid in the waste liquor. Steel mills using more than 20 tons of acid per day should be able to produce recovered acid at a cost equal to or less than new acid. If the copperas is to be converted into new acid in either a contact or chamber plant the cost will depend on the relation between restored and new acid handled in this plant. One of our subsidiaries has a large recovery plant of this type and I can therefore give you the approximate cost of the various acids for a plant handling waste pickle liquor. New acid produced from pyrites will cost about $10. per ton of 100% H_2SO_4 and recovered acid $14. A steel mill using this type of plant would produce about 70% of recovered acid and 30% new acid; therefore the cost should be $12.80 per ton. In a recovery plant where the free acid is not neutralized such acid can be produced at about $8 per ton and the combined operating cost should be $11.40 for each ton of 100% H_2SO_4 if the proportions are 23% free acid, 47% from ferrous sulphate and 30% new acid. There is a saving of over a dollar per ton if the free acid is recovered and, besides, the first cost of such a plant is much lower.

Only larger mills can afford to install their own acid manufacturing plants, others can restore the free acid in their own recovery plant and ship the ferrous sulphate to an existing acid plant or a community plant in which case the freight charges will add at least $2. per ton to the cost of new acid. All these cost figures are subject to considerable variations due to size of plant and local operating conditions.

Mr. Spangler: I would like to add a word to Dr. Mantius' remarks. For the entire process carrying the production all the way through to the production of new acid, and carrying it on a large enough scale, we believe that the new acid will be produced slightly under the cost of what you will pay for the acid if you are buying.

Now, in addition, there is a possible credit that you will get from the value of the iron oxide that is recovered in roasting. That iron oxide contains a little more sulphur than the steel mills actually like. However, on the other hand, if the small quantity is taken into consideration when mixed with the larger quantities of iron ore regularly used we believe the mixtures will not contain enough sulphur to worry about. Of course, the actual cost of making the acid in the recovery process, as Dr. Mantius mentions, depends both on the quantity of material handled and the strength of what you start with.

The crystallization process involves a partial evaporization, and if it is done in a vacuum evaporator, that means steam; and if it is done in our process by direct fuel, it means a fuel cost there, so in either case the more you dilute the acid, the higher the fuel cost. Another point,—and I think it was misunderstood,—is that I said Pyrites should be available, on a basis of $11.00 or $12.00 per ton of sulphur content, to compare with sulphur.

Mr. Miller: I wonder if the gentleman can tell us anything about the disposal or the elimination of the pickling fumes, which seems to enter into another phase of pickling problems?

Mr. Spangler: You mean the fumes from the pickling plants?

Mr. Miller: Yes.

Mr. Spangler: Frankly, we have had quite a few years of study in acid recovery problems and we realize the fumes are a nuisance, but we have not worked out anything for their recovery.

Mr. Miller: Well, I mean the disposal of the fumes, rather than the recovery of them,—disposal of the fumes so that they wouldn't be a nuisance to the neighborhood.

Dr. Mantius: I think that such fumes could be absorbed by a water spray. The picklers should be covered and the fumes carried to a scrubber where the H_2SO_4 fumes are absorbed by a water spray and this water can then be neutralized. We have done similar work in the oil industry where the sludge acid is decomposed into oil and sulphuric acid and the sulphurous fumes are absorbed in alkaline water. Steel mills using electrolytic picklers have to dispose of the hydrogen which is rather dangerous.

Mr. Miller: Well, I was thinking along the line of hydrochloric acid, as well as sulphuric.

Dr. Mantius: Well, the hydrochloric acid will also be absorbed in the water.

Mr. Miller: I understand there has been some problem of it in the communities, where they were disposing of it by the spray process.

Dr. Mantius: You would have to neutralize the water, the same as you have to neutralize your drip. I don't think you can get away with it unless you neutralize it,—at least, not in the State of Pennsylvania, where they watch you.

Mr. Rolle: I heard Dr. Mantius make a statement that the steel producers do not give a figure on how much acid it took to pickle a ton of steel, and that

they got different results all over. I wish to take the part of the steel pickler on that score. You can't tell, because conditions are all different.

In pickling and in the amount of acid that is used, the cost depends entirely upon the amount of surface that is exposed. If you have exposed a ton in one piece as compared to a ton in a very fine thin gauge sheet, and the surface exposed is entirely different, the cost will vary with the condition under which the operation is performed. Also the concentration of the acid makes a difference on present-day consumption, because different concentrations are used.

Now, if you assume that any concentration of steel is removed from the pickle bath, it necessarily carries with it a certain amount of pickle liquor. Now, if that has twenty per cent acid it is washed and goes down the sewer. If it has only six per cent acid, it is also washed off, but in the twenty per cent acid there is three times as much going down the sewer as there is in the six per cent acid. Consequently, those figures will be all over the lot, depending on the particular production of the plant.

Another question I would like to ask is whether this recrystallization is based on sixteen per cent acid? Now, in the rod and wire mills I think you will find that there are very few men, who are pickling rods or wires, who are using sixteen per cent acid, or anywhere near that. What would be the effect of recrystallization at four or five per cent acid with a ten or fifteen per cent iron sulphate composition?

Mr. Avery: Well, perhaps it is my job to answer that question. First, however, I would like to discuss the matter of cost. We, of course, have some actual cost data on the plant at Butler over a considerable length of time. But unfortunately, the "Roosevelt Recession" has been a factor during all this period, so the plant has been operated at a low capacity. We do not feel that we should at this time give any actual figures, but we can say this: The value of the acid saved is considerably greater than the cost of the operating of the recovery plant. There is therefore a saving in the over-all cost of pickling, and in addition, there is the added value due to the elimination of neutralization and disposal.

The next point was whether sixteen per cent acid solution could be generally used. Frankly, we do not know, but we see no reason why it couldn't be. One of the objectives of the Butler-Little Process was to develop,—was to find the best over-all condition for good pickling speed and pickling quality combined with low cost of recovering acid.

It worked out, as I said, for greatest economy in the range of sixteen to twenty per cent sulphuric acid, but associated with the acid is quite a high percentage of iron sulphate, which apparently has the effect of, well, I won't say inhibiting,—I don't know just what it is,—but it represses the activity of the acid and appears to make inhibitors less necessary. With regard to the possible building up of impurities in a closed system to such an extent that they present difficulties; and the only answer is to make comparative tests under given conditions. We see no reason why such impurities cannot be taken care of.

Mr. Lynne: Well, I would like to offer a suggestion to help this gentleman from Chicago.

Earlier in the strip game, continuous picklers were made without covers, and naturally they had to put their pickling tanks in a wood building, because that is the only thing that would last any length of time. Lately continuous strip picklers have been installed in steel buildings, the same as the rest of the building for the hot mills and the cold mills, and a very good example is right here in the City of Detroit, at the Ford Motor Company, where they have two continuous strip picklers working in a building, whereby the finished product of the steel comes back to the pickling department for shipping, and if you go through that department there, there is no trace of any fumes, although there will be two picklers there with four sixty-foot tanks in operation. Their method is using rubber-lined pipe and covers over the pickling tanks, to conduct away the fumes, and there is a rubber lined fan to conduct the fumes away from the tanks, and then the fumes pass through a scrubber, where they are sprayed with water,—the water naturally taking out the acid-laden fumes. While there may be some fumes that get by this scrubber at the top of the station, which is located about thirty feet above the height of the building,—and I might remark that their tanks are located in a chain of six buildings,—not a very good location,—but they have installed on the top of these stacks a condenser which condenses the fumes, so you will have the fumes going over the roof of the adjoining building. I think you should go up and see it.

Prof. Hodge: I would like to ask a question in regard to some of these processes. All of the States, it seems, are getting more rigid in their laws regarding the discharge of wastes into the streams, and some of the States do not even allow the iron and steel manufacturers to discharge the rinse waters from textures, and they won't even allow them to start sanding the streams.

When plants are properly designed to operate on concentrated pickle liquor, do they operate on the rinsing or washwaters, or will there have to be a neutralizing plant of some kind in addition to the acid and recovery system?

Dr. Mantius: I think that I mentioned before that all washwaters would have to be neutralized, especially in the state of Pennsylvania. Steel mills could greatly reduce the amount of washwaters if, in the batch picklers they would allow more time to let the acid drip off from the sheets and wire, and if the continuous picklers are equipped with wipers or squeegee rolls. I have stated previously that the mill could save acid by maintaining the acid strength in the batch picklers, reduce the pickling time and allow more time for the acid to drip off. Further, I believe that strip mills could operate the continuous pickler so that the acid will pass through the picklers also continuously; this method would require a few pumps but should give more uniform results and reduce the acid consumption.

Mr. Spangler: I would like to add one point to the remarks of the gentleman who raised a question just a little while ago, about running the pickle liquors to a low strength free acid, and asked what would be the effect on these recovery systems? If you propose to use a recovery system that involves neutralization, it would be advantageous to have them low-strength, as they would not have to be neutralized as much.

On the other hand, your low-strength free acid liquor would have a little more water in the system, which would make your evaporation cost go up a little more. But the fact that the acid may be down to two or three per cent does not prevent the operation of the process that involves neutralizing all to ferrous sulphate, and then recovering your acid from that.

Mr. Long: The term "neutralization" is being used quite handily, but there are several problems connected with that, particularly as Dr. Mantius pointed out, in Pennsylvania, where we have Act 294.

In Dr. Mantius' paper it was mentioned that the low neutralization is objectionable because it passed the precipitate oxide and that it can no longer be used. There are a lot of new systems in operation, the approvability of which are under question in Pennsylvania, and it is not exactly clear how they will work out. I should like to mention that there is available now a limestone neutralization process, which apparently handles satisfactorily all sulphuric pickle liquors together with all the pickle liquor solutions, which Professor Hodge mentioned. Both as to operating costs and as to steel companies located on the banks of a river, where the area required to neutralize it is very small, it seems to work satisfactorily. But there is another question involved, that is, in Pennsylvania. What will we do about the problem of disposal of acids other than sulphuric? That includes both the record of sulphuric acid and also the ferron process. It makes no provision for the treatment of acids other than sulphuric and the hydrochloric acids.

It is of course possible to neutralize those acids by lime. It is probable, not possible,—that it will be permitted in Pennsylvania to discharge the inevitable, the calcium chloride and the formate of magnesium sulphate. As far as I know, there has been no reasonable solution to that particular problem suggested, but it is a problem which very definitely, unless the Pennsylvania law is changed, will face all pickling plants that use acids other than sulphuric.

Perhaps some of those operators who have been approached by the sanitary board of Pennsylvania on this particular problem would care to comment on what they are going to do in the way of handling this material. Surely we can't evaporate it all in dryness, and that is the only solution we can think of to take care of it. To take a specific example, they pointed out that in the ferron process small amounts of mixed acids do not interfere with the process. That is true as far as neutralization of the acid is concerned, but if for example, there were a small amount of hydrochloric acid to be handled, it could take hydrochloric acid, which could be dumped into the river; and also you mentioned that limestone could be used. Now, again, unless there is a subsequent treatment with sulphate, putting magnesium sulphate into the river, you are very definitely going to have another problem on your hands. In other words, you

solve one problem and you will be subject to the other problem.

Mr. Lynne: Well, in the first place, I want to say that he is completely over my head. The only experience that we have had so far is with sulphuric acid, and on the filter press design that has been worked out, we are reclaiming all of the salts mentioned. I have seen gentlemen take a glass of water from the filter presses and drink it without any harmful effects, and I think that end of the thing has been very well taken care of, although I am not a chemist,—but I think that answers the question.

Mr. Long: Well, might I ask what happened when the man took the drink of that water?

(Laughter).

Mr. Long: Mr. Chairman, with reference to this problem of a plant where they pickle the alloy steel, and where they used to have to use these mixed acids, we know that calcium chloride is one of the soluble fluorides in the water, and that is discharged into the stream, and the water in that stream is used by some city farther down the stream for their water supply. If there is more than one million-weight of chloride in the water, that causes an effect upon the teeth, and they had quite a campaign throughout the west,—some cities had to have an entirely new water supply because of the effect of it upon the water.

Now, if you neutralize with a high magnesium, you get magnesium sulphate,—you get what is called by another name, epsom salts,—and if there is nitric acid, which is soluble, a certain amount of that is all right because they help to raise the oxygen rather than keeping it reduced in the water. In Massachusetts, I have heard of a place where they had to put it back in the stream. They had some large reservoirs on top of the hill, and it would run into the solution in the water, and they had to run it back.

Then another method they had was to add a little of this nitrate to this water. Of course, that wouldn't be so bad, but there is a problem there where you have mixed acids.

Mr. Hodge: I would like to ask one more question, in discussing the mechanical mechanism of the ferron process with the various small wire products, particularly referring to the valley from which I come from, the question is often raised: Why on earth do we use the filter press to clarify a solution which has a high percentage of salts? What is the particular objection as to the continuous type of filter?

Mr. Lynne: The reason we want to reclaim the salts is that we feel that we are going to develop this line. In using this material as a product that can be sold, by mixing it with certain clays and manufacturing a high grade insulating material which will withstand 2200 to 2400 degrees temperature, and also for operations for the manufacture of fertilizer,—and it seems that this is going to have quite a market, because from our study at the present time it looks like there will be between six and nine thousand tons of the ferron produced, if the industry will swing over to that product. These tests are being made by various companies throughout the country, and we think, or at least we are pretty sure, that we are going to have a solution for that problem which will have a value placed upon the product produced, which will in turn reduce the operating cost of disposal.

Mr. Spangler: On behalf of my own company, we will be very glad to have the people from the Wire Association see our plant in operation, and I think Dr. Mantius will be glad to say the same thing. Our plant is at a chemical works owned by the concern with which Dr. Mantius is connected.

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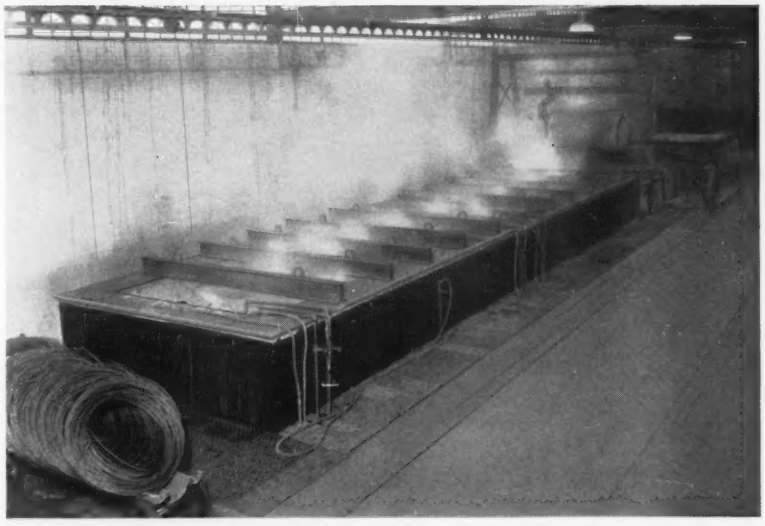

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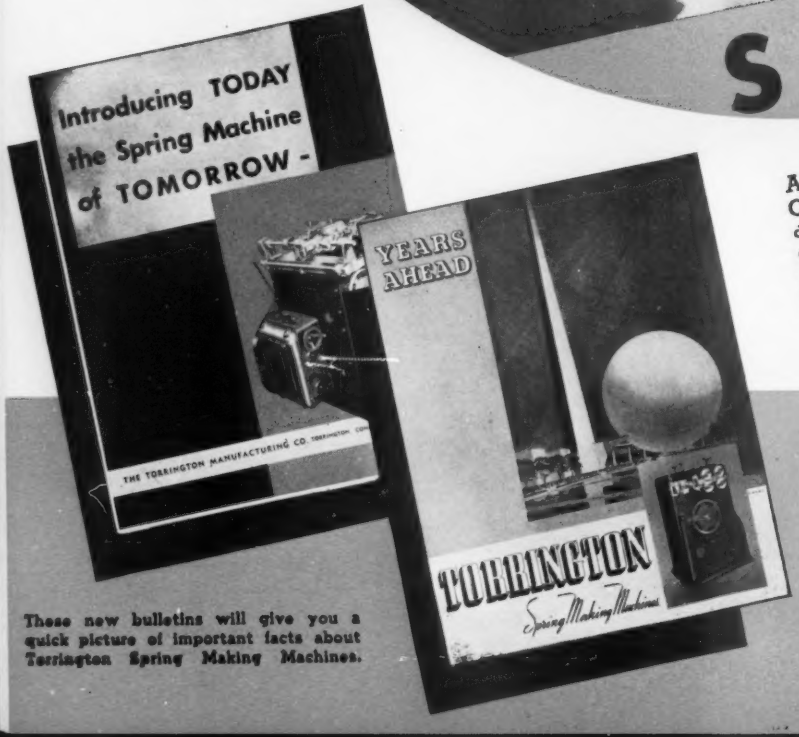

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FERROUS DIVISION

Meeting, Thursday, October 20, 1938 - 9:45 A. M.

Chairman of Meeting
Dr. S. A. Braley, Senior Industrial Fellow,
Mellon Institute of Industrial Research,
Pittsburgh, Pa.

PAPER: "STAINLESS STEEL WIRE"

By J. K. Findley, Metallurgist,
Allegheny Ludlum Steel Corp., Dunkirk, N. Y.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 517)

We have this morning another paper to be presented which brings into the meetings, I believe for the first time, the question of stainless steel. There are several who are producing stainless steel today, and a good many who are drawing it. The problem of the use of stainless steel is one which has caused considerable difficulty in a great many places—not because it is stainless steel, but because it is another grade of steel, with which we have not been familiar.

Now, it is true that the use of stainless steel probably never will reach the tonnage quantity, which is used in carbon steel. However, its importance has a place, and it is with extreme interest that we have presented to us this morning a paper on stainless steel wire, by Mr. Findley, of the Ludlum Steel Company. Mr. Findley.

(A paper was then read by Mr. Findley, on "Stainless Steel Wire.")

— Discussion —

Chairman Braley: I am sure that any questions you have to ask Mr. Findley, he will be glad to answer, if he is at liberty to do so. Remembering, of course, we are in the same position as I mentioned before, that the stainless wire is a new process and as yet there are a lot of things that each fellow thinks he knows which he does not, and he may not be at liberty to answer. I am sure that is not Mr. Findley's attitude, but probably the attitude of those who have permitted him to give the paper.

Now, if there are any questions?

Mr. Westphal: I would like to ask about the annealing of eighteen and eight or thereabouts, do you have the temperature at all times at approximately 1900 Fahrenheit, or do you alter it as you would be drafting down in the process to a given finished size?

Mr. Findley: Our first anneal will be at 1900 degrees after the hot roll, then suppose we were drawing that down to 150 round, which is our process stage. We draw it in three parts from a quarter-inch to 150 round. If that wire is going to be annealed and drawn again we will anneal it about 1750 or 1800 degrees on that anneal. We also like to have the last anneal at 1900 degrees. If it is a final anneal before shipping the wire out we want it at least 1900 degrees or if it is the last anneal before some cold working is put on it, such as on a rope wire or spring wire where we anneal and then draw it to size, we use a 1900 degree anneal. We find it gives a much more uniform anneal. At 1700 degrees you will get it just as soft, your Rockwell hardness will be as soft as if annealed at 1900.

Mr. Westphal: Another question. What are you using for cleaning-hydrofluoric acid?

Mr. Findley: Sulphuric acid about 10 per cent and we find it is about 20 per cent.

Mr. Westphal: That will do the job all right?

Mr. Findley: That does it all right. Mr. Hacker may not think so. Of course, it does the job all right. There is always a disadvantage in this pickling, you have to dig under the scale to get it off, you have to eat under it. There is a considerable loss, particularly in the straight chrome. You don't lose so much when you are pickling straight chrome, we find there is quite a little weight lost and stainless wire is rather costly. There has been considerable labor on it, and the initial cost has been pretty high. Sulphuric acid does the trick, we pickle in sulphuric first, and remove the scale, and then if it is a finished pickle we dip it in nitric and hydrochloric mixture and finally in nitric.

Mr. Westphal: Thank you very much.

Mr. McCarthy: To what extent do you use the water quench in annealing these materials?

Mr. Findley: We always water quench it 18 and 8.

Mr. McCarthy: How about when you get up to 25 chromium?

Mr. Findley: We still water quench them. I don't know if it is necessary or not, but we find it is the easy thing in mill procedure. You give them too many ifs and ands—

Mr. McCarthy: I was wondering when you got down to finer sizes like in hydrogen if the water quench would be necessary?

Mr. Findley: We introduce the hydrogen from the outgoing end of the tube, that is our practice, and that stream of hydrogen is always flowing against the wire and it cools rapidly enough.

Mr. McCarthy: Small sections also?

Mr. Findley: Yes.

Mr. McCarthy: That can only be applied to relatively fine wire and as the sizes get coarser you think the water quench would be desirable?

Mr. Findley: Yes, when we do it and say we are going to straddle annealing all wires under 32. But in the past, where we have open fire annealing, we have taken 50 pound coils of perhaps, 020 or 024 round wire, and that makes a pretty heavy bundle, and if we took that out of the furnace and let that air cool rapidly, the outside would cool rapidly and the inside would maintain a red heat. We figure it maintains a red heat too long and we water quench a size like that.

Mr. McCarthy: There isn't anything objectionable,—if I remember right you use that overhead furnace and trap door in quenching water. There isn't any objection to the Patenting type of annealing?

Mr. Findley: None whatsoever.

Mr. McCarthy: In fact, I think it might be a little bit more desirable in some cases.

Mr. Findley: I can certainly see no objections to it. I don't know why in the bigger sizes it should produce any better wire. We have found it in small sizes to produce a better wire. There would be certainly no objections. We never used it because we never had that kind of equipment. It is rather expensive equipment.

Mr. McCarthy: What I had in mind is that in line with ordinary patenting speeds you would have to reduce the speeds for this type of work, say a speed of about 15 feet per minute or thereabouts the furnace 40 or 50 foot long, using a high temperature, say 2200 or 2300 degrees fahrenheit for the furnace, that certainly should provide enough time for solution and proper fusion of the constituents.

Mr. Findley: We feel all the furnace has to do is to get the temperature up.

Mr. McCarthy: That is the point I wanted to bring out. You haven't found that a soak is necessary?

Mr. Findley: We have an open fire that if we anneal at 1900, we find you need a certain soak, but that is to make sure the inside of the coils have the heat in them.

Mr. McCarthy: Yes, I appreciate that. The reason I brought out those points is that the objectionable feature to the patent annealing would be because of the speed and the absence of time at temperature.

Mr. Findley: I think it would save a lot there in scaling.

Chairman Braley: May I add a point to this? We have annealed wire in the Patenting furnace and it runs very, very nicely.

Mr. McCarthy: We do that right along, and I was just wondering—

Chairman Braley: Well, I mean on stainless and the only objection we find to it is when you get into larger sizes in the neighborhood of three-eighths, you have a pretty stiff thing to handle to put through a strand anneal and in those sizes, I think it is preferable to do it in a bundle because of the difficulty of handling it in a furnace. But from the standpoint of scaling, I think it is much better to handle it in the strand.

Mr. Findley: On this strand annealing we do have the temperature higher than we expect the wire to reach. We figure the wire reaches 1900 to 2200 degrees. We have through experience regulated our speeds.

Mr. McCarthy: In fact most any patenting furnace, the majority of the patent furnaces will have areas in them which will have a high temperature like that, maybe even higher than that. Like where the flame burns, but it doesn't necessarily follow that the steel comes up to that temperature. If you are just trying to get a temperature head to increase your heating—

Mr. Findley: That is right.

Mr. Stirling: Have you any suggestions on the proper type of 18-8 material for the flat rolling of round wire or the round edge flat wire? Is there any different types of machinery you need?

Mr. Findley: You are speaking of particular wires like flat rolling for steering wheel spokes?

Mr. Stirling: Flat rolling for springs.

Mr. Findley: We have always felt that the lower carbon were around about 18½, as near as you can come to 18½ chrome and 9 per cent nickel, has worked best for spring wire applications. I don't know whether we are right in that or not, that is a matter of experience to date.

Mr. Donachie: What mechanism was it that caused the failure of your stainless steel Fourdinier wire?

Mr. Findley: It apparently worked hardened, your neighbor can answer that, Mr. Brown. Apparently it worked hardened. As the screen moves work hardens considerably and I think this work hardened to a point where it failed due to fatigue. Mr. Brown may be able to tell you about that.

Mr. Aiken: You mention on rope wires and stainless steel tensiles of about 300,000 pounds, I believe. Do you have a specification on torsion on that 300,000 pound amount of wire, and if so what are they and have you had success in meeting them?

Mr. Findley: We have never accepted any specifications on torsions. Lately we did increase for the British Air Ministry specifying torsions and we have just had to tell them that we can't accept any specifications on that. We have done some work but it is pretty tricky. Most of it is good, but once in a while one will come very flukey and twice in one spot and come very low. But we haven't found any failure that we know of that can be traced to that failure.

Now, when you speak of this aircraft controllable where we think the, particular melt has something to do with its success, well, I am just trying to recall what our values were on there. But we have had the wire tested and it was found a lot of it withstood very good twisting tests and didn't stand up when it was fabricated into cord and then run over the sheave or pulley. Some of the wire that wasn't as good in the tests stood up wonderfully in the fatigue tests on the finished rope but we could never get a connection between the two.

Chairman Braley: There was one other question I would like to ask. You mentioned using high nickel for cold working purposes and tensile, which you obtained on the regular 18 - 8. Suppose you draw down a high nickel, in the neighborhood of 11 per cent, to the same extent that you draw an 18 - 8 for spring wire. What would be your ultimate tensile?

Mr. Findley: You wouldn't get it over 250,000 tensile. We could not drive it over that, that has been our experience.

Chairman Braley: In other words, you reached a maximum tensile with a constant chromium as dependent on the nickel there with a decrease of the nickel?

Mr. Findley: That is right, if we get the nickel too low and have about 17 per cent chromium and less amount of the nickel,—if it was a wire we couldn't handle it at all. We couldn't draw very well without a cracking and it wouldn't be a usable wire.

Chairman Braley: You don't draw any wire of that type?

Mr. Findley: No, not for high tensile wire. We do find that this 18 chromium and 11 per cent nickel were about three per cent molybdenum. It work hardens a little better than 18 chrome 11 nickel without any molybdenum. In other words, we have been able to get around 275,000 tensile in some cases to 300,000 tensile with such an analysis where we couldn't with just 11 per cent nickel.

Mr. Westphal: In cold heading stainless steel is it necessary after the first cold heading that there be a heat treatment or is it possible to trim before heat treatment. I am speaking on the cold heading operation of the stainless wire?

Mr. Findley: You mean on hexed heading? I was just talking to Mr. Braley about that before the meeting started. In some cases, yes, and in some no. I have noticed some of them when they shove it through a trimmer those trimmings fly and they are pretty dangerous, some fellows get cut pretty badly. Some of the wire seems to act pretty dead; some of the hexed headed or headed materials seem to work pretty dead. But we have had experience where some of it seems pretty lively in trimming and we generally recommend annealing before trimming, but if they don't do it all right, they are still trimmed just the same; they won't crack. The fact is some of the trimming may fly in somebody's eye.

Mr. Westphal: In making bolts, do I understand that after heading, trimming the head and pointing the end, there must be a heat treatment before threading? In other words, that there must be two heat treatments in making stainless steel bolts from the bolt wire to the finished bolt?

Mr. Findley: For roll threading and cut threading it is not necessary at all.

Mr. Westphal: One heat treatment from the acceptable bolt wire to finished bolt, is that all?

Mr. Findley: One treatment is all. Most of the material, I know, is not heat treated at all after it leaves the mill. Most of it is just cold headed as steel wire is, rolled and threaded, or if it is going to be cut thread, we use a bearing type selenium for cut threading. It doesn't have to be heat treated at all after it leaves the mill except for treating. Some of it is heat treated when they slot the heads; some of it is heat treated.

Mr. Westphal: Generally speaking it calls for one heat treatment, is that right?

Mr. Findley: I wouldn't say that. Except for trimming hex heads, where you are trimming hex heads.

Mr. Braley: On that score, Mr. Westphal, I was mentioning to Mr. Findley before the meeting,—we had a case just the other day where some .328 wire, it was headed about 3½ or 4 diameters, and trimmed to a square head without annealing, which is a much more difficult trim than a hex head. And, of course, as far as your roll threading is concerned with the material you are starting with and it just has a skin face after the final anneal. In other words, the finished draft consequently is in very good shape for a rolled thread, which a great many of them are making. Finally, most of our cold heading wire we anneal thoroughly, pickle it, and draw a line and soap coating on there, but we use just enough draft to be sure the coating gets on there tightly, then we, of course, get enough stiffness so it isn't mushy when it is cut on the heading machine, cut and bent over and gets tangled up in the machine.

Mr. Westphal: You mentioned a lime soap lubricant. Is that generally what you use with stainless steel?

Mr. Findley: Yes, among our competitors and ourselves too. We use an oxide coating that I mentioned. We found it a very good coating, the only objection to the oxide coating being that it must be pickled off. It won't pickle in nitrate and if it is pickled off it turns black.

Mr. Donachie: Some of these so-called Austenitic stainless steels don't remain as Austenitic stainless steel, after they have been worked. There seems to be some sort of change in them, and I wonder how much effect that has on subsequent forming operations.

Mr. Findley: I guess it is generally felt that when you are cold working the 18-8 type it turns to ferrite. I think that is the general belief. It becomes magnetic as it changes to ferrite; it becomes magnetic, and, of course, the higher nickel types don't change so readily. That is why they don't work so hard because they don't change as readily. I don't know what effect it would have in the forming operations. If you work, cold work them too much, naturally they have got too high a tensile to form very readily.

Mr. Donachie: The reason I ask that is in relation to some mandrel forming of spring wire, everything physical seemed to be all right, between what was the good wire and what was the poor wire, and the only thing we could find was that in one sample ferrite seemed to precipitate a little more and I thought I would ask you if there was a relation between the ferrite and the formability.

Mr. Findley: I mentioned before that

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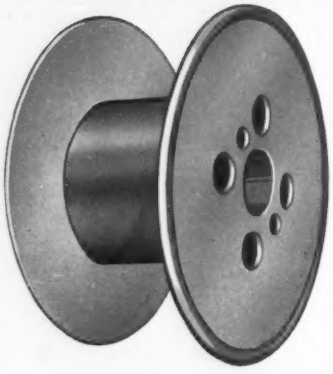

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we thought it had to be cold worked a little before it could be uniform. Just as Mr. McCarthy brought out, you have to put a certain amount of cold working on there before you obtain any uniformity. His slide showed that very well.

Chairman Braley: Are there any further questions? Mr. Findley, have you the drawing of wire or of subsequent cold forming?

Mr. Findley: I don't know much about the subsequent cold forming. I know on cold heading, on a lot of cold headers they will use white lead, but in drawing a small wire, particularly a diamond wire, we use soluble oil and water. In drawing through Tungsten carbide, we use this lubricating coating or this oxide coating or a lead coating for a lubricant.

Mr. McCarthy: This oxide coating is very simple. Mr. Findley has explained it a good many times. All you do is put on an oxide coating.

Mr. Findley: I always feel embarrassed when I can't tell that story—

Mr. Lewis: This whole business makes me think of the old days when moving pictures were just coming in. There was one film that showed in the foreground a railroad track and in the middle distance was a nice grassy bank and a pool. On the bank was a beautiful young lady, who was preparing to take a dip. She took off her dress and her shoes and stockings, and as the film rolled she begin to take off one thing after another, until it was obvious there was just one thing left, and just then a freight train rolled along.

The manager noticed one fellow that came every night for a week. He said, "Young fellow you seem to like our show." The young fellow said, "Well, by God, some day that train is going to be late." (Laughter.)

Whenever anybody from Ludlum reads a paper or writes a paper on wire I don't hear that lecture or read that paper because I admire the way they circle around and around that question of the oxide coat. I have seen the thing, I have been through the mill; I have seen them put it on. It is the most beautiful thing I have ever seen in my life the way that stuff draws. I have seen them put it on, but I don't know how it is done. I got so crazy once that I went to Mr. Lonzberg, the Vice President. I went into his office and I made sure the window was open so when he threw me out I wouldn't break the big plate glass. And I asked him to tell me how that coat was put on. To my surprise he didn't throw me out. He thought for a little while and he said, "I will tell you, I will tell you how to put it on, if you will tell me how to get the damn thing off."

That is as far as we ever got.

Mr. Findley: It is really so simple that I can't see why everybody doesn't know it. I didn't advise it, and I don't have the permission of the mill to disclose it.

Mr. Lewis: I remember my younger brother once when he was a kid about seven years old, and he said, "I almost got a horse." And I said, "How did that come about?" He said "I asked Mr. Burns if I could have his horse," and he said 'no', but if he had said 'yes' I could have had it."

I think that is about as near as we are ever going to get to that oxide coating.

(Laughter.)

I was that close in getting that from Mr. Lonzberg.

Chairman Braley: You are asking the question about how this coating was put on. It might apply to a question I asked one time relative to a process which was very secretive. The old fellow was very blunt in his statement, as a rule, and I asked him a point blank question as to how he did it. He looked at me, and he said, "Young man, it cost me thirty years, and a million dollars to do that. Do you think I am going to tell you how to do it for nothing?"

Mr. Findley: As I say again, I feel embarrassed not to be able to mention what it is because I found that everybody seems to answer the question I ask, and all my competitors answer the questions I ask of them.

Mr. Lewis: From all I have seen I would advise you to hang on to it.

Chairman Braley: Lots of times you find out more about things when you don't ask, or sometimes it is better not to ask about a lot of things. Any further questions?

Mr. Horwedel: Is there any relation between a particular analysis, and the ability to meet the specific requirements of armature winding wire?

In other words, are you using a point of limit between the elastic limit, and the tensile, and the elongation?

Mr. Findley: One particular plant demanded a limited elongation. I felt at first, well, when we first were making that, they wanted the permeability of a certain value, but I guess they had no way of testing it other than putting a magnet somewhere near it, and if it didn't attract it, why, it was within their limit. But they got hold of a permeameter and that was a bad day for us for a short time. But we thought to overcome that we would use a higher nickel wire, and in that way prevent the work hardening, and keep it Austenitic longer or rather keep the Austenitic at a higher tensile, and we were able to do that. We were able to keep it non-magnetic. But we were falling short on elongation.

Now, we have found that about 18 chrome 9 nickel will accomplish the results. We don't draw it so far and it is afterwards baked. That gives the physical as well as keeping it non-magnetic.

Mr. Horwedel: Do you feel there is a need for a non-elastic limit specification on that type of wire, from your experience?

Mr. Findley: As I understand it, and in their use when they are winding these armatures. They are winding them under a tension, and naturally the wire has to be strong enough so it doesn't start stretching. For that reason I believe they do need an elastic limit specification. I don't know whether they need it as high as they have had it, because the tension they put on that wire, as it is wound on to or banded on to the motor, is certainly,—well, the elastic limit they ask is there.

FERROUS DIVISION

Meeting, Thursday, October 20, 1938 - 2:00 P. M.

Chairman of Meeting

M. G. Ensinger, President and General Manager,
Union Wire Rope Corp., Kansas City, Mo.

PAPER: "ROPE WIRE"

By W. R. Bloxdorf, Metallurgist,
Macwhyte Co., Kenosha, Wis.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 505)

THIS PAPER RECEIVED THE 1938 WIRE ASSOCIATION MEDAL AWARD

(A talk was given by W. R. Bloxdorf, of the Macwhyte Company, Kenosha, Wisconsin, on "Rope Wire.")

— Discussion —

Chairman Ensinger: Anyone who has any questions to ask please state their name and their company affiliations, so the reporter may be able to enter it into the record.

Mr. Hammerstein: Mr. Bloxdorf, in your early part of your discussion, you mentioned so-called iron wire, which is in effect a low carbon. Have you conducted any experiments with that which I could believe would truly be called iron, namely, three-hundredths of 1 per cent carbon and under?

Mr. Bloxdorf: We have made some fatigue tests with material of that type, and we find the higher carbon steel gives better fatigue results. Whether or not that reflects in the fatigue resistance of the finished rope or not, I am not prepared to say. These fatigue tests were made in bending on a high speed Haigh-Robertson machine.

Mr. Hammerstein: The reason I ask is I have a record of the early rope and the exact time when it was made. It was made by a rather obscure process —it was made by what was called "Swedish Iron" and its carbon content is about .03. There was no way of testing the sample of rope that we got back to find out what the physical properties of the wire were. It was a worn rope, but its service record was available. It was in service about 25 years on an elevator and we replaced it with a so-called iron rope and the service record nowhere approached that. I recall one thing which characterized that particular wire. It was of particularly large grain size. Something like Mr. McCarthy showed this morning was to be avoided. It showed that if you drew less than say 30 per cent, and then 12 per cent, and then drew it again you would get an abnormal grain growth.

In other words, the microscope showed that it had a grain side that you could call very abnormally large grain. I don't believe there is any wire like it, or any steel like that being used for wire now. I haven't run across it.

Mr. Bloxdorf: The particular problem of which is the best type of steel to use for iron wire is something that, I feel this way about: That the little higher carbon material drawn from stock that has been given a full annealing or normalizing treatment, will give you a better wire all around. I feel that that is true.

Years ago the type of iron wire that was used in elevator cables particularly was of very large grain, and it was of very low tensile. Which wire is actually the best I don't know, but I am of the opinion that the higher carbon material is the better wire.

Mr. Westphal: I assume you make full micrographs of the heat of steel that comes in, to get a reading of the grain size.

Mr. Bloxdorf: Yes, we do.

Mr. Westphal: Therefore, what do you consider the right grain size, say, on carbon from 50 to 60, from 60 to 70, and 70 to 80. What do you consider is a good grain size for the hot roll section?

Mr. Bloxdorf: By that, Mr. Westphal, I take it you mean the grain size determined by the MacQuaid-Ehn grain size test?

Mr. Westphal: Yes.

Mr. Bloxdorf: I think the steels having grain sizes of about No. 3, will work out the best in actual mill practice. That is, you will get less variation, and any variation you do have in your heat treating, particularly will not be reflected so much in the physical properties of the finished wire. With finer grain steels you have to be a little more careful in controlling all of your heat treating operations.

Mr. Westphal: Figure about No. 3.

Mr. Bloxdorf: Yes.

Mr. Westphal: Up to five is satisfactory.

Mr. Bloxdorf: Yes. As a matter of fact, I have seen steels with grain sizes running from No. 2 to way off the chart and still they made good rope wire.

Mr. Westphal: I suppose you have seen grain sizes that were up to seven and eight, and that they have worked satisfactorily?

Mr. Bloxdorf: Yes.

Mr. Westphal: Do you find that grain size has a tendency to grow finer as you get near the eutectoid, that is 80 or 90 carbon steel, that the grain size is apt to get finer.

Mr. Bloxdorf: That is true.

Mr. Westphal: But it responds well to Patenting and will make good rope wire. Do you agree with that?

Mr. Bloxdorf: Yes. I think the most important thing, as far as grain size is concerned, in rope wire, steels, is the grain coarsening temperature. It is desirable, as I have stated, to induce a coarse grain in the patented stock. I think if you have a steel that is coarse grained at 1800 degrees, whether it be fine grained at 1700 or not, you are going to get a good wire.

Mr. Seymour: Along that line of grain size, I agree with you that a fine grain steel can be made into pretty good rope wire, but if you are going to get uniformity both in your tensile strength and torsions, I think you will get a greater uniformity and better results, by using a coarse grained steel. In other words, grain size from one to four. I think that has been very definitely proven. I think there are several fellows here who will back me up on this statement: That the coarse grain steel will produce a more uniform and better rope wire than a fine grain steel. In patenting if you can get the fine grained steel up above the grain coarsening temperature, it should produce good rope wire, but the response to patenting in a fine grain steel is not as good as it is in coarse grained steels and as a result, you don't get as uniform a result.

I think Mr. McCarthy will back me up on that.

Mr. McCarthy: Needless to say, I will back him up on that, because I have said virtually the same thing before, and I certainly am very well pleased to find that Mr. Bloxdorf's work has shown that the coarse grain steel is the more suitable for cold drawing. And just as he found, it is more suitable because it gives a better and quicker

response to the patenting treatment. The theory is absolutely sound, and as we all pointed out, you can get results from a fine grain steel, and sometimes good results, sometimes it might be difficult to choose between the two, but if you go back to this question of reaction rate, response to heat treatment, you will find that the characteristics of a coarse grain steel are such that it will lend quality and lend uniformity to the structure and that is what we are after. The difference is very slight and I think that back a few years ago when we discussed the same thing, we commented on the same point, that the difference seems rather slight, but if in production in the mills, we study an accumulation of twist test values, it stands out, and to anyone who does that amount of work, there is no question in their mind as to what steel you should use.

Now, there is one comment in connection with fine grain steels. If we go above the grain coarsening temperature in torsion, Mr. Bloxdorf said, it shouldn't make any difference. I would like to take exception to that because fine grain steels in the mills, especially in a process patent, in the rod it isn't quite so important, but with any amount of the cold working, variations will make a marked variation in grain growth. If you have a coarse grain steel to begin with you get better results.

That is particularly true, if the Patenting is subsequent to some cold working. Even in the rod, however, when we coarsen fine grain steels they seldom coarsen uniformly. There is always that tendency where certain areas will start to grow and grow to an enormously large grain and right around them we have areas, which are comparatively fine grain; the typical duplex structure that we get is typical of all steels that are right on the edge between a coarse grain and a fine grain. So I think that rather than confuse the issue, the safest operation is to employ the coarse grain steels. and the range Mr. Bloxdorf and Mr. Seymour set up here, from 1 to 4, are all right. The range that he suggests, that No. 3, is very desirable, it fits very nicely in any good, open hearth practice. It doesn't put a burden on the open hearth, it doesn't mean they have to make the extremely coarse grain down to size No. 1. No. 3 can be made very nicely in the open hearth without any additional expense and it all fits very nicely in the picture. I don't want to make a long speech, but there is one thing in this paper of Mr. Bloxdorf's as long as I am on my feet, that we are all interested in, and we might as well get at it, and the quicker we do it the better, and that is this heat treating and patenting problem.

Any remarks I make here I want you to feel that there is nothing personal about it, and it is all in a friendly spirit. Mr. Bloxdorf, what, in your opinion, is the better type of grain size or the better fibre for rope wire? You show both the short and the long fibre? Which would you prefer for rope wire?

Mr. Bloxdorf: I personally believe that the long fibre wire will give you better service when it is put into the rope.

Mr. McCarthy: I agree with you that the long fibre does.

Well, now, in your tests when you compared the conventional Patenting treatment with the electric treatment, were you referring to the lead Patenting operations?

Mr. Bloxdorf: Yes, that is quenching in lead.

Mr. McCarthy: A quenching in lead.

Mr. Bloxdorf: Yes.

Mr. McCarthy: Apparently, from your work, you can get a coarser grain size. You do get a coarser grain size from the conventional method than you do from the electric process.

Mr. Bloxdorf: That is true.

Mr. McCarthy: That is about what we would expect because the electric process is a quick heating up to temperature and complete solution but there is not sufficient time for grain growth.

Mr. Bloxdorf: That is the case with that particular process. There is one thing about the structure that you get in the electric direct resistance patenting. It is entirely different from the type you get in the conventional patenting in that the grain boundaries are not easily discernible under the microscope, and your ferrite precipitation is very slight. I think that is primarily due to the fact that with the direct resistance method, you are quenching from the actual temperatures, whereas in conventional patenting it takes time for the wire to come from the furnace into whatever type of quench you are using.

Mr. McCarthy: I think that is a good point.

Mr. Bloxdorf: It is really surprising to note the drop in temperature of the wire in possibly six or eight inches from the furnace before it gets into the quench. The wire may be 1800° F. at the mouth of the furnace, but when it gets in the quench it is 1600° F.

Mr. McCarthy: I notice you show a tensile value of 147,000 pounds for the conventional patenting and 164,000 for the electric patenting. Don't you think it would be possible to raise the tensile strength of the conventional material up to 164,000 lbs. per sq. in.?

Mr. Bloxdorf: That particular tensile strength of 146,000 lbs. per square inch was obtained by the regular practice we employ. By changing the treatment it would be easy to get it up to a tensile equivalent to that treated by the direct resistance method.

Mr. McCarthy: Now, if we did have the tensile up to 164,000 and assume we had the lead bath at a temperature not less than 900 between your furnace temperature and lead bath temperature, assuming it was not less than 900, have we any reason to believe that the structure resulting from a tensile strength of 164,000 in the conventional method would be any more harmful, or would injure the material any?

Mr. Bloxdorf: I don't think it would be the same type of structure, as you would get in the direct resistance patenting.

Mr. McCarthy: I don't think it would be the same type of structure. I agree with you there. But what I had in mind was some of these properties here you showed a higher tensile strength than you do for the electric patent, as compared with the conventional. Now, if we were to raise the tensile strength of the conventional patented material to 164,000 pounds, we would, of course, have, and it would be perfectly all right to have, a coarser grain size associated with it than we can in the electric patent. But at the same time, is there any reason to believe that the subsequent properties would develop after cold working would be any different?

Mr. Bloxdorf: I think they would be similar.

Mr. Patterson: In comparing the conventional type of lead patenting against electrical resistance, I am wondering whether or not you have found any difference in the physical properties or in the reduction of area torsions, or percentage of elongations, assuming that the conventional type was adjusted to increase the tensile comparable with the electrical resistance.

Mr. Bloxdorf: I couldn't really answer that.

Mr. Patterson: I will repeat it. In comparing the conventional type with the electrical type resistance, and everything else being equal, what have we found with respect to difference in physical reduction in area and torsion and elongation?

Mr. Seymour: Going back to Mr. McCarthy's argument here about this talk a few minutes ago, of the difference in tensile between the conventional patent and the direct resistance patent, wasn't it true that both the conventional patent and the direct resistance patent were done at the same temperatures, practically?

Mr. Bloxdorf: The maximum temperature was a litte bit higher with the conventional.

Mr. Seymour: But your lead temperature was practically the same.

Mr. Bloxdorf: Yes.

Mr. Seymour: I don't quite agree with Mr. McCarthy's statement that by taking the conventional patenting method and adjusting your temperatures to get the same tensile strength after patenting that you had under the direct resistance, that you would get the same results because it would be a much harder structure. It wouldn't draw as easily, and as a result, the elongation would be down and the reduction of area would be down, so you wouldn't get the same results in the finished wire even though you started with the same tensile strength on the patented material. I have seen quite a few structures on this direct resistance patenting, in a way it kind of knocks our theories of patenting a little bit cock-eyed. The structure is exceedingly fine. As a matter of fact, you have to resolve it up to 5000 magnification to really bring out all details of the structure. Your statement that the long fibre would make the best rope wire does not necessarily hold true in this case. I think with the conventional patenting we can consider the long fibre as making the best rope wire. With this direct heating, I don't think we can justify that statement because it does materially increase the fatigue limit. Isn't that right? Don't you think that the fatigue limit in your tests show considerably higher on the electric patented?

Mr. Bloxdorf: That is true.

Mr. Seymour: Some of the tests I have seen made showed the elongation to be 1 to 2% higher in the case of the direct resistance patenting.

Mr. Bloxdorf: We found the elongation was practically the same.

Mr. Seymour: The torsions were not quite as high.

Mr. Bloxdorf: Well, they were well above the minimum requirements, and they showed a very nice degree of uniformity.

There is one thing about the wire that is electrically patented, and that is it gives you an improved surface in the drawn wire. That, I think, is one of the things that helps the fatigue resistance as the fatigue properties are ordinarily determined.

Mr. Seymour: There are a couple representatives here,—if anyone wants to ask anything about the equipment I think Mr. Troutman of the Trauwood Engineering Company,—and if anybody wants to ask anything about the equipment I think Mr. Zur would answer those questions.

Mr. McCarthy: I would like to get some idea as to the approximate price per ton of heating by his resistance method. Has anybody any information on that?

Mr. Zur: All right, the approximate cost of treatment of the wire heating runs between 175 and 185 per kilowatt hours per ton. That is for the wire heating alone.

Chairman Ensinger: Are there any further questions of Mr. Bloxdorf?

Mr. Seymour: There was a fellow who was saying something about wire rope the other day, and he said something about jagged torsions, and said he expected it to be brought up at this meeting, but I haven't heard it so far, and I thought maybe it would be a good idea to have a little discussion on this subject. I want to ask Mr. Bloxdorf a question as to whether or not if the torsions are within the limit of the specifications, and you get a jagged break should the wire be rejected? And whether you have made any study of what causes a jagged break or what effect it might have on the value of the rope wire.

Mr. Bloxdorf: That is a question that I am not fully prepared to answer. But I might say this: We had one particular batch of improved steel wire at one time that gave us extremely poor torsions, but still we purposely put it into a rope and watched that rope. We could find no difference in the service that rope gave over the service which a rope gave that had wire with excellent torsions in it.

Mr. Seymour: I didn't want to start an argument,—we have the wire users and steel makers together and I thought this would be a good time to get together and have a little understanding as to how far we should go in rejecting the material, which has torsions within the specifications.

Chairman Ensinger: If you hold your question for Mr. Hammerstein, he is going to talk on the testing of rope wire, and he will answer what you are dealing on. You are out of Mr. Bloxdorf's paper now. Are there any further questions?

The next paper which we have this afternoon is presented by a man whom I have known for a good many years. He has done a great deal of technical work, as well as practical work on the testing of rope wire. They, themselves, have bought many hundreds of tons of rope wire in the course of their business career, and therefore, he should know something about those torsions, Mr. Seymour;

Meeting, Thursday, October 20, 1938 - 2:00 P. M.

PAPER: "THE KIND AND NECESSITY OF TESTS FOR ROPE WIRE"

By H. K. Hammerstein, Chief Engineer,
Broderick & Bascom Rope Co., St. Louis, Mo.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 551)

I now take a great deal of pleasure in introducing Mr. Hammerstein, Chief Engineer of the Broderick and Bascom Rope Company, St. Louis, Missouri, as our next speaker.

(A talk was given by H. K. Hammerstein, Chief Engineer, of the Broderick & Bascom Rope Company, St. Louis, Missouri, on "Wire Rope.")

— Discussion —

Chairman Ensinger: The floor is now open for discussion. If you have any questions you would like to ask the author of the paper you may ask them now. I believe your question now is quite appropriate, Mr. Seymour.

Mr. Seymour: I wanted to get the steel makers' opinion then I was going to ask Mr. Hammerstein to give us his idea of the fellow that uses the wire.

Chairman Ensinger: If Mr. Bloxdorf was a little tardy in catching your question I will attempt to answer that for you. You asked what would a jagged torsion indicate? Was that your question?

Mr. Seymour: Providing the number of torsions reached the specifications.

Chairman Ensinger: I would say if it meets the minimum it would only mean, as Mr. Hammerstein has told you, that that wire was not as acceptable as one that has a smooth torsion, and probably if you would test more of that coil of wire you would have a rejection. A jagged torsion break also shows slivers, seams, and pipes and surface defects and overdrafted wire. I would like to say right here that jagged or wormy torsion breaks are very rare in our mill. Now, the trade and manufacturers question the value of a torsion test as far as ductility is concerned. For instance, the English Manufacturer disregards torsions, they don't use it, they use bends. In this country we disregard the bend test and use torsion, and the latest information is that the A. P. I. has now deleted the bend test from their specifications, meaning the American Manufacturers are relying solely upon the torsion test and not the bend test. And it will definitely show you your pipes, seams, slivers, and overdraft wires and that humpy, crawly wire many times comes from a pipe or sliver. It will also show rolled in oxide, ferrite fingers, and surface decarbonization. Those can come out in a torsion test. I, myself, doubt if it shows you anything as far as other properties are concerned. Does that come near answering your question?

Mr. McCarthy: Mr. Hammerstein, I note that you express a desire to have a higher elongation in rope wire. I wondered if you have any idea as to how we would go about getting that increased elongation.

Mr. Hammerstein: We buy all our wire, we don't make it, hence this question is best answered by a wire producer. My personal reason for thinking it might be an advantage is—sometimes wire rope, in making quick bends over a small radius sheave and under a heavy load, is subjected to a momentary stress on the crown of the rope (or the strand) which is in excess of the elastic limit of the wire, which, as was mentioned in my paper, is from 85% to 93% of the ultimate strength of the wire. Its ultimate strength has not been exceeded, or else the wires would have broken, but the elastic limit has been exceeded. When the rope flexes, or bends, it is in compression underneath and in tension on top, and there is a definite movement of the wires from underneath to the top. If it flexes too rapidly for this movement to completely take place, especially in a rope that has been in service and which in consequence may have become somewhat 'set' or rustbound, the wires do not have a chance to mechanically adjust themselves, and hence wires having a somewhat higher elongation, or percent of elongation, might stretch slightly, rather than break.

Mr. McCarthy: I would like to offer something to clarify this question of elongation in rope wire and I will be glad to have anybody contradict me if it is found otherwise. I think we will find in cold drawing material that the elongation does go down to a value in the neighborhood of 2 per cent, that is in rope wire where we are drawing upwards of 70 per cent. You might get variations of 1½ to 2½% elongation, but when you talk of anything up in the neighborhood of three or four or five percent the only way you can get

that is by reheating the material to temperatures in the neighborhood of six or seven hundred degrees fahrenheit. So as far as the manufacturing of the wire is concerned there isn't much that can be done to produce four per cent elongation, if you want to study the problem, you could just take the wire and heat it up and then see if your increased elongation gives you the results you are looking for. I think that is the only approach to the raising of the elongation up to that point.

Mr. Hammerstein: Your opinion is that elongation cannot be increased on a cold drawn wire without in effect drawing it back and heat treating it, and by so doing you affect the other physical properties, namely, you might get a decrease in tensile?

Mr. McCarthy: No, I didn't say that. I didn't say you necessarily affected the other properties. You might increase the tensile. It doesn't necessarily follow that it will increase the torsion properties, either, I am just merely offering the thought that you cannot get it by cold drawing. When you make up your mind you are going to reduce the wire 70 or 80 per cent you also make up your mind you are going to accept the percent under elongation that goes with it. If you want the other,—I personally know that heating the wire up after drawing will produce four or five per cent elongation, and might not produce a better rope. I wouldn't commit myself on that.

Chairman Ensinger: Mr. Brunton tried that in Scotland and called it a rawhide wire. He heat-treated the wire just before the final draft; then gave it a light final draft, and it went up to seven and eight per cent elongation. It was tried out in wire rope by several rope manufacturers and found to be a dismal failure, because that stretch holds no load, and the result is that it would just stretch down and break and Mr. Hammerstein is quite correct. There is a limit to where your elongation should stop. When you say 2 per cent that is the average today, but I think that there are possibilities with your statement of large grain size and long fibers, that we will eventually, by the help of the steel makers, help our elongation where it won't be just so much rubber. Do you follow my thought?

Mr. McCarthy: Yes, but you see, the fact is that you get the same condition generally in low carbon and high carbon. In fact, wire drawing takes the elongation out of the material, uses up all it has got in it, it doesn't seem to me as though a lot could be done in cold work operations.

Chairman Ensinger: You want to remember one thing in rope wire, you cannot draw up to the limit of your elongation due to the fact that you have got to figure your rope wire is going to get an additional cold working after it goes in service, and if you work it too close you may have a good testing wire, but after it goes out into service you are going to have a failure due to the cold working the rope gets in service.

In other words, I have seen wire go out with very fine torsions, 30, 32, and 33, be in service three weeks, and come back and have spotty torsions anywhere from seven up to maybe thirty, due to the extra cold work that was put in the metal. It slides, and it slips and it whips and it gets all over, and you have to leave a leeway; that is, don't over-draw the wire. It is the same as just taking a hammer and beating on a piece of metal,—it will eventually change its structure.

Mr. McCarthy: I think there is something of value in what you say, but I feel that in any of our rope wire if the Patenting is done properly and drawing is right we have a lot of reserve plasticity and ductility still remaining.

Chairman Ensinger: Have you tried any of the specifications up to 300,000 pounds per square inch in say wire of .070 and larger?

Mr. McCarthy: I don't know whether they have or not.

Mr. Ensinger: I know you have, and I am speaking of what I learned of it. We get that strength, and still get the torsions, but we are so near to the critical point of drafting that the fibers have practically slipped by and a little more cold working, in actual service, completes the slippage and your wire is cracked and brittle. Now, I have probably opened another field for metallurgists because I don't know a thing about it.

Mr. McCarthy: I wouldn't want to contradict you there, I don't know, it is sort of a new phase, I know this: If the wire itself, from which the rope is made, isn't in a proper condition, you don't have to have a 70 or 80 or 95 per cent reduction in order to reach the limit of how much further working it can stand in the field.

Chairman Ensinger: Speaking of elongation, you can take your steel, good steel, as good as you describe and work it up, and it will pass the factory test, and will pass your inspector, and then when it goes into service, because it was worked up to nearly its limit,—in wire drawing you are liable to run into trouble. We stick very much along the lines as you suggested in your paper.

Mr. McCarthy: I think probably, generally, that we are thinking along the same line. I think possibly there may be something in the quality of the wire itself that might have influenced you in that. Cold working and over-drafting, the amount of cold work the wire can still stand afterwards, as I said before, can be very low and still not have had an awful lot of reduction in drawing. I think what you are speaking of, generally, is a quality of a good piece of rope wire. I think a good piece of rope wire would have the type of residual ductility and plasticity that it will need. I think we are talking about the same thing.

Mr. Hammerstein: Gentlemen, I didn't want to leave an incorrect impression. You can take high carbon wire and in effect, under draw it, as your diagram shows, and get high elongation. But to my mind, an underdrawn wire, by which I mean a wire that has not received the amount of cold work or drafting that experience and practice has indicated it should have for its carbon content, is not as good for wire rope as if it had received the proper amount of reduction of area by suitable cold work and in consequence has a higher tensile strength but lower elongation. A steel whose analysis indicates that, say, 220,000 p. s. i. is its normal tensile strength when suitably drawn, can also be drawn to a tensile strength of, say 180,000 p. s. i., and higher elongation, than at 220,000 p. s. i. Theoretically it would appear as if the 180,000 p. s. i. wire has a reserve of cold working that can be used up in service, but in actual practice, I believe it has been proven that this doesn't work out. You obtain as durable a wire by underdrawing, as by drawing to where it should be drawn.

Mr. Ensinger: Mr. Hammerstein, the question of elongation is not so important as your elastic limit, is that true?

After you have taken your wire up to your elastic limit, then your curve goes straight out and you get a long elongation. From the point you reach your elastic limits, from here to here (indicating), that is worthless to you, because you want your wire to have the ability to recover itself after you pull it out, and if it can't recover, the next load it gets, it is going to break.

Mr. Hammerstein: You are speaking of permanent elongation?

Chairman Ensinger: And from that stretch on out you may get another per cent of elongation in your rope wire, is that other per cent any good to you?

Mr. Hammerstein: I doubt it, because you have a permanent deformation, as you say. If you have over-stressed it you have got a hump in it. What I understood was possibly instead of processing your wire so as to get your elastic limit at 95 per cent of the ultimate, it might be that your elastic limit is more nearly 95, then you have a point there where you get more recovery. Is that what you mean?

Chairman Ensinger: Mr. McCarthy, that is what happened to the rawhide wire of Brunton's. That had a very low elastic limit and a very high elongation.

Mr. McCarthy: That would be right under that treatment.

Chairman Ensinger: You want the highest elastic limit?

Mr. McCarthy: Sure, that is right.

Mr. Akin: Mr. Hammerstein, you are the purchaser of rope wire, I presume. You buy galvanized rope wire. Do you have any set specifications on torsions on the galvanized wire? How much attention do you pay to the torsion?

Mr. Hammerstein: Well, generally, the application of galvanized wire is one where torsions do not play such an important part, only in so far as reflecting the durability of the wire. We get galvanized high carbon wire in which the torsions will meet those for bright wire of the same grade.

Mr. Aiken: I mean hot galvanized.

Mr. Hammerstein: I am speaking of hot galvanized. We get hot galvanized wire for rope, and if the torsion specifications for that grade in bright wire are 30 the galvanized wire is acceptable if it makes, say 20 torsions. I think the lower torsions after galvanizing might be due to a roughening of the surface of the steel, or to a possible change in grain structure on the outer portion of the wire due to the heat of the zinc bath, which is around 900° F., I think.

Mr. Galloway: Getting back to Mr. Seymour's question. I would like to ask Mr. Hammerstein first whether he feels, as a purchaser of rope wire, he would be justified in rejecting that lumpy torsion wire even though it has two torsions above the minimum, or even though to go further than that, while the torsions may meet the minimum, the defects that are brought out in that torsion, may be such that he feels that he is justified in refusing that. I would also like to ask what you feel is a reasonable tolerance on rope wire sizes. That is a compromise between the wire drawer and the rope maker. Also I am wondering why do we state these Pullman names on wire specifications?

Mr. Hammerstein: Answering your first question: We have rejected wire that made lump torsions, although the torsions exceeded our minimum. It was done after consultation with the makers of the wire, and it was agreed that that wire, although it passed our test, would not be suitable for the purposes intended. Your second question was as to size tolerance. There again, I would say the size tolerance depends upon the use to which you are going to put the rope. For example, selecting a wire size at random let's take .041, that size of wire might be used in one of three or four or five or six different diameters of wire rope because of the construction. Now, the more wires you have in a strand and the greater the oversize or undersize of the wire you are using, the greater will be the possible variation on the finished rope from the diameter you are aiming at. The purchaser of wire rope often sets a tolerance limit on the diameter of the finished wire rope. If you are using,—well, we will put it this way, if you are making a 6 by 7 wire rope, 6 strands, of 7 wires each, and you are off three thousandths per wire, it is going to affect the tolerance of your finished wire rope very slightly because you only have 42 wires. However, if you happen to be making a 6 by 61 wire rope, 6 strands of 61 wires each, to cite the other extreme, that increase of two or three thousandths per wire, is going to throw you away off on the diameter of your finished wire ropes because of the total of 366 wires. And it isn't usually possible in ordering wire or drawing wire to say beforehand what you are going to use the wire for. So, therefore, I think you have to provide for any contingency for all wire, and ask for as close a tolerance as is reasonable. The permissible tolerance that a wire mill is able to produce depends upon their skill and equipment. As I mentioned in my paper, for .050 wire, I believe we permit one thousandth under and say 1½ thousandths over the specified diameter, which would mean that if we ordered 10 or 20 tons of it, the smallest wire could be 0.049″, and the largest 0.0515″. Actually we get wire and much of it, with no more than a ½ thousandths variation which might be from .0495″ to .050 inclusive and again it might be .051″ to .0515″.

There is one thing in regard to size. Even ten years ago, if your wire didn't vary more than three thousandths from one end of the coil to the other, why, it was swell wire. If we get a thousandth's variation now between one end of the coil and the other we generally report it, and the dies are examined. Your third question was regarding the classical names given to wire rope grades. Possibly someone else can answer that better than I, but it is my opinion that the name crucible which was given to the 195,000 p. s. i. grade came with the use of steel for wire rope, the steel presumably made in crucibles, then cast, and subsequently rolled into rods.

Then next, I think came Plow, and this was supposed to be a higher carbon steel similar to that used for Plow shares. The derivative Improved Plow is understandable, and then when it was found necessary to classify wire still closer, they used either the term "Mild Plow" or Extra Strong Crucible Case Steel, from which the word "Crucible" has now been dropped.

Mr. Lawton: What is your opinion of electro galvanized rope wire in comparison to hot galvanized wires?

Mr. Hammerstein: That is a pretty hard question to answer. You mean for a running rope, or for a guy line?

Mr. Lawton: I don't know the difference.

Mr. Westphal: He means as far as tests are concerned.

Mr. Hammerstein: As far as tests are concerned, I have tested very little,—you mean in so far as the zinc coating is concerned?

Mr. Lawton: Yes.

Mr. Hammerstein: You are asking me if I were buying rope wire, zinc coated, whether I would prefer electro-deposited zinc, or hot dip zinc?

Mr. Lawton: Yes.

Mr. Hammerstein: Honestly, I don't know, because I haven't had enough experience with it. No doubt they are both good if properly done, but I imagine you can get a heavier zinc coating on a wire if it is done electro galvanically. I think there are a lot of factors entered into that that I am not qualified to answer.

Chairman Ensinger: Is there any further question that anyone desires to ask?

Mr. Washberg: What tests are used for ductility?

Mr. Hammerstein: I would say that depends upon the purpose for which the rope made out of it is intended, if it is a standing line like a guy line, where you anchor both ends, and there it stands, torsions obviously may not mean much. If, however, you have in mind something used in the oil fields, such as a cable tool drilling line, or a sand line, where the rope is subjected to the same kind of stresses and strains as a bright wire, I think, that the more nearly the physical properties in your galvanized wire are to that of bright wire the better the chance of satisfactory service. Did that answer your question?

Mr. Washberg: Yes.

Mr. McCarthy: In connection with this coating, galvanized coating we are talking about, I would like to offer a personal opinion. It is not backed up by a lot of experimental work, or data on rope life, but I would say that if the coating on the wire required thickness of coating, something within a reasonable range of thickness, that the galvanized wire will be preferable from my standpoint. If, however, the amount of coating gets up to the point where it is beyond the reasonable limits of the hot dip galvanized method, you are compelled to use the electro galvanized method. It is a question of speed in galvanizing, and how much coating you can take on without seriously upsetting the physical properties in connection with hot dip galvanizing. I think that can be gotten around to a certain extent by electro galvanizing. Although I think the use of electro galvanizing introduces some other features, possibly absorption of hydrogen which might be objectionable.

Mr. Graine: Now, of course, I have a lot of reasons why I like the electro galvanized wire over the hot type, having had experience with both of them. I would like to suggest a few things on electro galvanized wire, which I think will show a little superiority.

The first one is due to being able to galvanize without any lead treatment or heat treatment of any kind, the physical properties on electro galvanized wire will more nearly meet the physical properties of a bright wire. The second one is while I have not made any test myself, I have seen quite a bit of information on it, that is due to the fatigue resistance. We all know that in the hot type galvanizing we have seen the effect of the pitting on the steel base, whereas with electro galvanized wire we don't have any of that. We have less pitting of the surface, and consequently less spots where fatigue was started.

Mr. Braley: I wonder if anyone here has had any experience with the manufacture of galvanized wire for aluminum core cables? That will answer some of your questions with respect to galvanizing our physical properties.

Mr. McCarthy: I wonder if Dr. Braley would care to tell us what his experience has been?

Mr. Braley: Very tough. The physical properties actually required on the core for aluminum cable,—is tough because of the elongation and bends required when it is galvanized. Speaking of the heat treatment and the relative effects between the two, although I don't consider this is a meeting where we should discuss qualities of galvanizing, however, in order to obtain the physical properties that are required in the wire, it is necessary to give it a heat treatment, consequently the properties are changed materially, particularly if the elongation is advanced by the heat treatment as necessary to give to it.

Mr. Hammerstein: I take it that the elongation of that wire is materially increased.

Dr. Braley: 4 to 5 per cent minimum and 10 inches.

Mr. Hammerstein: And the bends are decreased?

Mr. Braley: Increased.

Mr. Hammerstein: Your torsions decreased and your elongations increased, and your bends increased?

Mr. Braley: Yes.

Chairman Ensinger: Are there any further questions before we adjourn?

Being no further questions I take the privilege of thanking Mr. Bloxdorf and Mr. Hammerstein for their very fine papers, and the meeting is adjourned.

(Adjournment.)

METALLURGY OF WIRE

THE WIRE ASSOCIATION LECTURES

By B. L. McCarthy, Metallurgist,
Wickwire-Spencer Steel Co., Buffalo, N. Y.

A series of three lectures designed to present this difficult subject in a manner which will make it understandable to the layman — Presented before the Wire Association — Oct. 17-18-19, 1938.

Part I — Principles of Metallurgy — See November, 1938, Wire & Wire Products - Page 655
Part II — Thermal Reactions — See December, 1938, Wire & Wire Products - Page 711
Part III — Metallurgy of Steel Wire — See January, 1939, Wire & Wire Products - Page 17

Tuesday, October 18, 1938
Morning Session, 9:30 A. M.

(A lecture was given by B. L. McCarthy, Metallurgist, Wickwire-Spencer Steel Company, Buffalo, New York.)

Subject: The Principles of Metallurgy

— Discussion —

Chairman Granger: I am sure there are some questions you will want to ask of Mr. McCarthy. We only ask in return that you give your name and speak loudly enough so the stenographer can get your remarks.

The meeting is open for discussion.

Mr. McCarthy: You don't have to hesitate to ask any question you wish. I don't know all about this subject myself.

Mr. Donachie: Mr. McCarthy, what happens to the amorphous material when grain growth takes place?

Mr. McCarthy: As I understand it, it is supposed to be a complete rearrangement of the atoms. When two grains grow together the force that overcomes the rigidity starts in the highest strain areas. This would be the amorphous material in the grain boundary atoms.

They immediately overcome rigidity and balance off and recrystallize in the cubic form and resulting in a complete rearrangement of the atoms of the two grains.

Mr. Donachie: The thing that puzzles me is that you have a boundary on a cooling action; the steel is heated up and cooled down, and you take the same steel and reheat it to some temperature lower than it was before. Why didn't the growth take place prior to that?

Mr. McCarthy: Now, in the first place what you say may be absolutely true, but I don't know about that. Once we heat a steel up to a certain temperature, you ask we can heat it to a lower temperature and get grain growth?

Mr. Donachie: What I am trying to get at is this: It is possible to take a steel cooling down from some temperature, we will say, and we get a grain size that we see in the microscope. The same steel could be reheated to a temperature again, which may be lower than the original temperature, and get the refinement of the grain in one case. Or if the temperature be lowered there is apt to be a growth.

Mr. McCarthy: You will find that the only time that reheating a steel will produce a finer grain size is because a strained condition was associated with the original cooling and you didn't have a proper balance or you cold worked the material and you set up additional strain that must be corrected.

But if you take a specimen of steel and cool it down slowly and establish a certain grain size, on reheating this same material, you won't get a refinement until you get clear up to the recrystallization temperature.

If you don't cold work it you will have to go to fourteen or fifteen hundred degrees Fahrenheit before you get a change. If you cold work it you set up additional strains which are relieved at the recrystallization temperatures as shown.

Mr. Donachie: The amorphous material finally becomes crystallized?

Mr. McCarthy: Some of it does. If we have fine grains and we reheat it and get coarser grains that means we have absorbed some of the grain boundary material and they have become crystalline that is we have a definite arrangement of the atoms in the grains.

Mr. Donachie: Wouldn't it be logical to think then that amorphous material might be just crystal?

Mr. McCarthy: If you want to consider a crystal made up of eight corner atoms, the amorphous material can be crystal fragments, and if a crystal is made up of atoms and you break off a piece you still have atoms.

Mr. Donachie: But you still have a crystal?

Mr. McCarthy: You wouldn't have a crystal unit unless you had the definite pattern that we are discussing. You are thinking of grain fragments; you might have some stray portions of the grain broken up.

Mr. Donachie: A grain fragment can still be a unit cell, and a unit cell is still too small to see.

Mr. McCarthy: That is is right. When you polish a specimen and examine it unetched you don't see any grain boundaries. What we see under the microscope when we talk about grain boundaries is probably a couple of million times larger than the grain boundary itself, because the grain boundary itself can't be any more than—well, it can't be two atom diameters or else you would have a crystal formed. So that the amount of that material at the grain boundaries is very, very small. You couldn't see it under the microscope but the atomic activity associated with it due to the forces present there and the increased solubility produces this trench effect or widening out and that is why you are able to see it.

The question of amorphous material at the grain boundaries has been discussed pro and con and in a lot of this work that I have presented here, there are points that are somewhat debatable, but I am not attempting to debate all the various steps as we go along, or else we wouldn't get anywhere. So we just arrived at a sort of an intermediate course on some of these things and presented a good working theory. Something that the average man in the mill, if he studies it close enough, can have as a background upon which to base his work.

This is all going to be published later on in the Wire and Wire Products and I think the published material will be much more complete and much more understandable than this explanation of it.

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Wednesday, October 19, 1938
Morning Session, 9:30 A. M.

(A lecture was given by Mr. B. L. McCarthy, entitled "Thermal Reactions.")

— Discussion —

Chairman Thomas: Does anyone have any questions to ask Mr. McCarthy?

Mr. Graine: Mr. McCarthy, you mentioned that you found that a coarse steel was better for high carbon. No doubt you have made some tests to determine that fact.

Mr. McCarthy: Yes.

Mr. Graine: I wonder if you would be kind enough to give us the results of the

tests you have made, that is, for physical properties, drawing qualities, and the difference between a coarse grain steel and a fine grain steel.

Mr. McCarthy: I think the most important results that I can give you are more in connection with spring wire than rope wire. I am not really in position to talk about rope wire but I understand the results have been equally as good. We have no definite figures on physical properties to show you but I can show you years of test reports which show that almost one hundred per cent passed the inspection bench day in and day out, using coarse grain steel. We could not get this with the other steel. In other words, the percentage of rejections on spring wire has just about been eliminated. I know that there are other influences that enter into it, but the uniformity with which the coarse grain steel responds to the patenting treatment puts it beyond question of doubt as to whether it is the right thing to use from our standpoint, and that is why we use it.

Mr. Graine: That has been my experience, too, Mr. McCarthy, but I thought you might have gotten to experimenting and that you might have some proof on that. It has been my contention that the coarse grain steel was much better in uniformity, and less rejections.

Mr. McCarthy: I will be frank to say that it would require a wide variation in heat treating and heat treating practices in order to bring out the difference, but when we take a patenting operation and are putting thousands of tons through in a month or a year,—the improvement is noticeable.

We cannot include all the variations of speed and temperatures, wires running together and things like that, which enter into it and because of this we don't get a good, clear picture of it when we take two steels and run them through together. However, if we take two steels and run them together and employ a low patenting temperature of around fifteen or sixteen hundred, and you compare the size of the fine grain, you find you can get better ductility with coarse grain steel than with fine grain steel.

Now, in another case we had some applications where this happened,—this did not happen to be rope wire,—but we needed a very high torsion. We never had any success on that particular problem, that is, what we considered success, until we went to the strictly coarse grain steel, now for that particular application we select the charge very carefully, we used nothing but special charge, and the trouble has cleared up completely. I worked for a long time studying the influence of coarse and fine grain steel, and while we couldn't put it down in black and white on paper, we could take heats that wouldn't work and study them, and find the duplex structure, and we would take other heats that were uniform coarse grain steels and we could get good results. So we came to one conclusion. And another thing we want to remember, too, theoretically it is absolutely sound, from the standpoint of reaction rate the importance of quick grain coarsening in patenting can't be overlooked. Patenting is at best a short heat treatment, and I think that is best, — when at its best it is short; the shorter the better. When you start working along those lines and you have a steel wherein grains coarsen very slowly, you are going to have areas of coarse pearlite. Coarse pearlite does not produce good wire.

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— Discussion —

Thursday, October 20, 1938
9:45 o'clock A. M.

(A lecture was given by Mr. B. L. McCarthy, on the "Metallurgy of Steel Wire.")

Mr. Findley: Mr. McCarthy, on your slides your percentage reductions were at 82 per cent. Do you figure those reductions in area, that is, cross-sectional area?

Mr. McCarthy: Yes, we do.

Mr. Findley: Well, I was just wondering how you figured that.

Mr. Lawton: You mentioned increasing the cooling rate of air-cooled wire from a patenting operation. Just how was that done? Is it by some sort of an artificial cooling, like an air blaze?

Mr. McCarthy: We had in mind the lowering of the Ar^1 transformation, by raising the temperature at which it comes out into the air, that can be one influencing factor; the other is the Austenitic grain size. That is, if we run the steel slow and produce a rather coarse Austenitic grain, we get one degree of lowering of the Ar^1 transformation, and we get a hardness in line with it; if we bring it out at a higher temperature we will get another hardening effect. I would like to say in connection with this, that all of these things are in this paper,—but I don't bring them all out. We find that in the patenting,—each steel has an air patenting tensile strength, which you can't vary much more than five thousand pounds. If you take pieces of a steel wire or rod and heat them for varying lengths of time in a furnace at say seventeen or eighteen hundred degrees Fahrenheit, and then take one out after about one minute, two minutes and five seconds and so on each all the way along the line and get the tensile strength. You will find the tensile strength will be lower than the original of the hot rolled rod; it will take a dip down and then start to climb up. When it gets up to a certain level it straightens out and stays straight for an extended length of time of heating.

Well, that, in my opinion, is the air patented tensile for that particular rod. Any attempt to get a lower tensile than that is slack patenting. Any attempt to fool with too high a tensile above that induces the possibility of Martensite. There is a tensile for each steel, take for example a .60 carbon steel, the correct air patenting tensile will be some 145 to 150 thousand pounds per square inch for a .45 carbon steel it may be 125 to 132, or in that neighborhood; this represents the best you can get on air patenting and produces good wire, wire that will draw down very satisfactorily.

If I created the impression that we deliberately soften or harden to any degree in the patenting I was wrong. What I meant was we control the Ar^1 transformation and produce the fine patenting structure, a fine pearlite, by some of the later developments in air patenting.

Mr. Callaghan: I am going to first ask a very simple question before I perform another duty. The question is this:—Is the tendency to form Martensite by quick quenching more pronounced in duplex steel than in coarse grain?

Mr. McCarthy: I think it is the reverse, the tendency to produce Martensite is greater in coarse grain steels than in the so-called duplex steels. You are referring to Austenitic grain and McQuaid-Ehn Grain size, I presume. The tendency would be for the coarse grain steels to form Martensite quicker than would the duplex steels or the fine grain steels.

Mr. Callaghan: Thank you, that clears up the point.

Now, Mr. Chairman, I rise to make mention of the credit due Mr. McCarthy for the very fine work he has done at this convention. It takes me back to the time in New York when outside the lecture room a little argument started about "Grain size". I said to Mac, having the pleasure of meeting him for the first time, "This sounds swell out in the corridor, but why can't we, as an association, have some of this on the floor of the meeting?" Some of you at that time will remember that every one of us were so secretive about our ignorance that we refused to admit it or refer to it in any way. I just want to pay a tribute to Mr. McCarthy which I believe will represent the mind of this meeting, and of the Wire Association generally. Mr. McCarthy has been the means of raising us from the ignorance of despair, and setting us on the road of more progressive thinking and a franker and better relationship to others in admitting what we are weak in, and getting kindly, corrective guidance from the other fellow, who now feels far more free to give it than he did four years ago. It has made the Wire Association a far better and a more progressive institution since that time when Mr. McCarthy first started to talk about "Grain size". I would ask, if the meeting meets my mind on it, that we stand and give Mr. McCarthy a real hand for the work he has done for this Association.

(A rising vote of applause.)

Mr. McCarthy: I certainly appreciate this very much. I am not at all surprised, however, to hear John say that. If you knew how many times he said that to me, personally, I expected when he got started that he would say just about what he did, and I appreciate his attitude. I have felt right along, and I said that at the beginning back in 1935, that matters of a technical nature are nobody's secret. Plant operations and the size of furnaces or the kind of furnace you use and the speed you are running at and the things you want to do in your own plant are your own business. If you want to give those out that is entirely up to you. But when we start talking about the influence of carbon and manganese, we start talking about the metallography, the changes in the microstructure resulting from heat treatment and so on. We are in debt to a lot of people who have gone before us for an awful lot of work that they gave us, and we have no right to try and be close mouthed about technical facts. It is not good business to begin with be-

cause it is just a question of time when everybody will find it out. And if you think you have a jump on your neighbor because of some technical detail you may have today, you won't have it tomorrow. At the same time, all working together, cooperating on this question of technical information, we can advance our own industry much further than if we drag the anchor all the way along and each one tries to stop the other on something first of all they have no claim to.

Nobody has any claim to any technical facts. Any technical literature or details that they work out, anything that I have ever contributed is so small as compared to that which other people have contributed that it shouldn't even be considered. So that it why I think that we should promote this sort of an exchange, an exchange entirely apart from company business. It is something that will help the industry as a whole and I hope it helps the Wire Association, because the Wire Association is a good medium, a good clearing house for just such exchanges as we should have. I guess that is all I have to say.

Mr. Westphal: Mr. McCarthy, you have given three points of excellent reasons for presentations to the Wire Association. I regret exceedingly that my official duties have kept me away from hearing them all. I sincerely hope that they will all be published in the proceedings in Wire and Wire Products, because I want to study them.

John Callaghan, as Vice President of the ferrous section, has done nobly in his full duty in expressing the appreciation of the Wire Association. May I join with the Vice President of the Wire Association, as President of the Wire Association, and also extend to you full appreciation for the full and diligent, and fine work you have done for us at this session.

That is all.

(Applause.)

Mr. McDonahie: Mr. McCarthy, do you find that with steel under 70 carbon, it is possible to complete the block ferrite precipitate,—to block it completely?

Mr. McCarthy: To prevent it from precipitating at the grain boundary? If the steel is uniform it is possible to get a patented structure without any apparent ferrite precipitate. It is there, of course, but it would be mixed. You can get that by raising the temperature, if you raise the temperature in which you quench a .65 carbon steel you can get up to a point where we have no ferrite at all, that is no ferrite precipitated at the grain boundaries.

Chairman Braley: Before I introduce the next speaker I want to add my compliments to some of the things that John Callaghan has just said and to the paper that Mr. McCarthy has just presented relative to the development that has taken place in the last few years in the Wire Industry. A good many are still in the room who were in the room at Buffalo some nine years ago when the first meeting of the Wire Association was held, when it was impossible to get anyone to rise from the floor to answer any question; lots of them asked questions but even they were afraid to ask because of secrecy involved in it.

Mr. McCarthy talked to you about patenting, and I remember in one of these sessions the question of patenting came up. Instead of discussing the patenting we discussed corn beef hash. And that was the terms that were applied, and it was on that basis that we started out in this Wire Association, which has developed into the very interesting set of papers and free discussions which we have had in the past two or three years.

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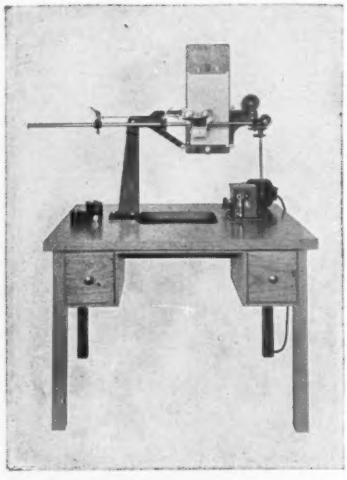

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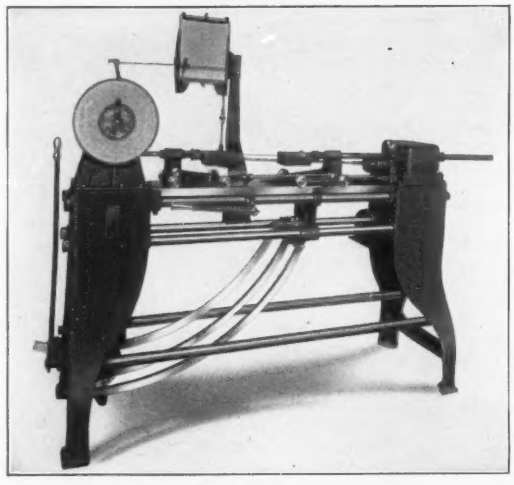

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NON-FERROUS DIVISION

Meeting, Monday, October 17th, 1938 - 2:30 P. M.

Chairman of Meeting
Wm. H. Bassett, Jr., Manager Metallurgical Development,
Anaconda Wire and Cable Corp.
Hastings-on-Hudson, N. Y.

PAPER: "NOTES ON THE ANNEALING OF COPPER WIRE"

By L. B. Barker, Engineer of Tests, Works Laboratory,
General Electric Co., Schenectady, N. Y.

(Paper Published in October, 1938 issue of Wire and Wire Products - Page 583)

(A paper was read by Mr. L. B. Barker, Testing Engineer, General Electric Company, Schenectady, New York, on "Notes on the Annealing of Copper Wire.")

— Discussion —

Mr. Sherman: Could you draw any generalization from the amount of cold working on the anneal on the various results you obtained?

Mr. Barker: Yes, we had a complete record of the history of the wire, and roughly it agreed with what we know to be the principles governing the effect of previous degrees of cold working. This sample in particular (pointing to curve on blackboard) that had a high re-crystallization temperature had been rolled with a number of light passes.

Mr. Rolle: I should like to ask Mr. Barker how he made the comparison between the product received from the various refineries and rolling mills at the same time. In other words, was a relationship established between the brands of copper and the quality of wire made from them or was the comparison made on the basis of the rolling mill supplying the rod from which the wire was drawn. We know that the rod mills receive wire bars from many refineries which may bring about a variation in the quality of rod. Therefore, there is a dual factor involved which calls for consideration. No. doubt you have done this but we should like to know how.

Mr. Barker: This test was run primarily to show the members of our shop supervisory staff that it was not possible to get a uniform degree of hardness even if our furnace control were effective to within a degree centigrade.

We take up later the question of the effect of the different brands of copper on our annealing problem. This test was run some two years ago. It was very effective in explaining to the shop why it was that they had to put up with the variations they were experiencing.

Mr. Bassett: If I read Mr. Barker's paper correctly, three of the 62 samples met the arbitrary specifications after three hour anneal, at 200 degrees centigrade. The majority of them met the specification between 225 and 275, so that he had thirty-five satisfactory samples after his 350-C anneal, twenty-two additional samples that met the specification between 350 and 400, and four additional that gave the requirements between 400 and 500.

Mr. Barker: That is, you are taking those that passed, and I am referring to those that did not.

Mr. Bassett: Yes. I was trying to bring out the number that were inspected at each range.

Mr. Barker: The data taken perhaps did not have the significance that it should have had because it was limited in scope. The test samples were representative of a month's production in just one shop. We have no record of whose copper was being used. We did have a record of how the flat wire was made, however.

Mr. Sherman: Was that wire rolled or drawn all in one direction, or did you have any reverses in it, off-hand?

Mr. Barker: The wire was reversed during rolling.

Mr. Horsfall: Mr. Barker, what type of furnace did you use during these tests?

Mr. Barker: Do you mean for the annealing of these samples?

Mr. Horsfall: Yes.

Mr. Barker: It was a special laboratory furnace. It was a tube furnace, 3 inches in diameter and 24 inches long, with a graduated heating element. The element was so spaced on the tube that we had ten inches in the center portion, which did not vary plus or minus 5 degrees centigrade.

Mr. Gundstrom: Was there any protecting atmosphere of any kind used in the tests there?

Mr. Barker: The samples were annealed without a protecting atmosphere. You may call it an open fire anneal, if you will, but of course the temperatures were not as high as those used in oper fire annealing.

Mr. Gundstrom: Well, in the practice of annealing there, you wouldn't tie that end, say, in the commercial type or bell type, would you? It wouldn't give you the same results over the same length of time, would it? In other words, if this was done on a proportionate scale for your production work, you wouldn't take the results of those tests and apply them to your production, would you?

Mr. Barker: Well, we have done that to quite a large extent. We control our furnaces by the actual copper temperature, and we can refer to our pyrometer records for the rate of heating of any particular load. That has enabled us to convert the results of laboratory tests into definite instructions for the operation of the furnaces.

Mr. Sherman: Did you experience any wide range of hardness readings on any one particular sample? Say take 57 as a high limit for your soft wire, was that the result of a number of hardness tests?

Mr. Barker: Readings were usually the result of a single test. In case a point did not line up on the curve, it is my recollection that we checked it. The amount of work to be done and the time available did not permit multiple checks. If your test data is plotting to a smooth curve, you feel reasonably sure that your testing is without significant error.

Mr. Pierson: What is the relationship between the hardness and the tensile strength of the wire?

Mr. Barker: It all depends on what type of hardness test you are using. The best set of technical data I have seen on that subject is in the British publication "Copper Data", published by the Copper Development Association. In that you will find curves relating the tensile strength to hardness values of various

types. The 15-T Rockwell scale that we use is not very satisfactory for relating the hardness to the tensile strength. Hardness measured on the 15-T scale approaches a maximum rather rapidly and levels off long before the tensile strength has reached the maximum. According to the curves in "Copper Data", the Vickers Diamond Pyramid hardness values increase with the degree of cold working in much the same manner as the tensile strength and would, perhaps, permit the two properties to be correlated. I do not want to go on record as recommending the Rockwell 15-T scale as the ideal way to test copper. We use it because it enables us to get a reading on a wide variety of wire sections.

Mr. Patterson: I believe you spoke about the rectangular section wire. How about the round section wire?

Mr. Barker: Are you referring to the variations in the final softness of the finished wire, or to the hardness and tensile strength?

Mr. Patterson: To the tensile strength.

Mr. Barker: I don't believe you would find that there would be any difference. Of course, it is more difficult to get a reliable hardness test on round wire than on flat wire. You have to grind the specimen, and do it very carefully. We have made hardness tests with the Rockwell superficial tester on sizes as small as .090 round, but I don't recommend that as a regular procedure. We are trying to get away from it in the laboratory.

Mr. Butler: Well, two weeks ago we had a machine running twelve lines of wire, and we took the strippings off of it, and two of those spools, well we had only two spools that did not anneal.

Mr. Barker: I believe your trouble has its origin in the variation in the copper itself.

Mr. Bassett: Mr. Barker, did you find that with the regular electrolytic copper?

Mr. Barker: Yes, this was all regular electrolytic copper.

Mr. Rolle: Just as a matter of record, I would like to have Mr. Barker tell us the methods he used to determine the compositions of the various wires that were tested.

Mr. Barker: We discuss that in the next section, in which we turn the problem over to the spectrographic laboratory.

Mr. Gundstrom: Mr. Barker, do you find differences in the copper from the same refinery?

Mr. Barker: Yes, we do. There was one refinery whose copper was almost 100 per cent,—but there would be occasional lots which would be high or abnormal.

The refinery which checked our samples investigated their own product using our test, and they said that they found that the annealing characteristic varied from the beginning to the end of the same furnace charge. That, of course, makes the problem all the more interesting.

Mr. Bassett: Do any of the representatives from any of the refineries wish to make any statements regarding this problem?

Mr. Craig: I would like to make one statement with respect to silver. I don't know that every one is clear on that, but it so happens today that we are making wire bars containing five, ten, fifteen, twenty, twenty-five, thirty and thirty-five ounces per ton. Of course, each range of composition is for a specific application, and it may be that one time you will have ten ounce bars and the next time 20 ounce bars, at 75 degrees C. annealing temperature, rather than the ten ounce, so that there are all those factors to be considered, too, particularly. That, incidentally, refers to the Lake copper.

Mr. Barker: According to the published data it would require an appreciable quantity of silver to cause the increase in recrystallization temperature that we have observed. When the spectrograph showed only a trace of silver or no silver at all, it was just another indication to us that the silver was not responsible.

Mr. Rolle: Before asking another question, I would like to ask Mr. Barker to tell us more about the refinery that he said checked his work. Did they inform you as to the method they used in checking your data?

Mr. Barker: As to the analysis?

Mr. Rolle: Yes.

Mr. Barker: No, they did not.

Mr. Rolle: That is, they simply said that they had checked your results?.

Mr. Barker: We sent them two large samples of quarter inch rod, one of which had tested high, and the other low, on re-crystallization temperature. They confirmed our tests and they ran some tests on their own product. They found a variation between the different heats, and also from one end of the heat to the other, which was unexpected,—at least, to me. I thought that a furnace full of cathode copper would be uniform in its annealing characteristics throughout.

Mr. Rolle: But when making that statement, didn't they assign any reason for the variation; I mean they did not answer your questions as to why?

Mr. Barker: No. They said that in their opinion there were probably 12 elements which were influencing the recrystallization temperature. While it might be possible to guess at those which were doing it, there was no definite evidence other than that, of the silver, of course, and that further work would have to be done.

Mr. Rolle: Well, that is practically what I would say too.

I think you deserve a great deal of praise for having started this investigation and given us the results obtained so far, but I think we all agree that there is more work still to be done by you and by others, including the refineries, before we get the complete answer as to why there is a variation in the hardness of annealed fine wire made from rod supplied by different mills and refineries. The refineries already do a great deal in the way of furnace control and of course keep a record of the conductivity, copper contents, and perhaps oxygen contents of each charge, but all of this is routine work. Many refineries make spectroscopic analysis on each charge, others more infrequently, but all of this work is routine and not for a single purpose such as is under consideration at the moment. In my opinion, these routine analyses are of little value in making a study of this nature and before coming to a definite conclusion as to why one copper anneals at a higher or lower temperature than some other, I think you will have to make precise chemical analyses on the coppers under comparison. Such analyses will have to be made of all elements known to have some effect on the annealing temperature and not merely of one or two. We know that the effect of some elements is counteracted by the presence of others.

I do not know whether I want to go so far as to say that there are 12 elements which may be influencing the recrystallization temperature, but I do know that ordinary electrolytic copper, such as is regularly produced by the prominent copper refineries, does contain many elements which may affect the recrystallization even though they are present in small quantities, that is to say, on the order of 0.002%. Of course, there are one or two of these elements which have a much more marked effect than others; particular attention should be given to these but the others should not be neglected. All of this clearly indicates that much more work will have to be done before one can say with assurance just what causes the variation in hardness of fine wire.

Mr. Barker: Yes, that is true.

Mr. Rolle: And there is still another point which should not be neglected in conducting an investigation of this sort; I refer to the oxygen contents of the copper. The oxygen contents of tough pitch copper usually varies from about 0.03 to 0.045% and constitutes the largest impurity. Not only is there a variation in oxygen contents of the various brands, but individual charges from the same refinery vary; sometimes the oxygen content varies throughout the same charge, as has already been intimated by Mr. Barker. Then we come to the question as to the difference between the effect of an element when in solid solution in the copper and the effect of that same element when it is in the form of an oxide and is precipitated along the grain boundaries of the copper. We know that variations in the condition in which certain elements are present bring about a change in the electrical conductivity of the copper. May these not also have an effect on the annealing characteristics? All of this points to still more work to be done.

Mr. Barker: Yes, that is right. It looks to me more like a Doctor's thesis.

Chairman Bassett: If you would permit the Chair to make just a few comments. We have confirmed Mr. Barker's and Mr. Rolle's remarks, and independent investigations have been made over the last two or three years, and we have found that the crystallization temperature of round wire varies considerably with the source of the copper.

We have confirmed Mr. Barker's statement that you cannot judge the recrystallization temperature by the battery F. A., the oxygen content, or the electrical conductivity. By making a complete analysis of all the commercial brands of copper, 20 in number, and determining the twelve elements that Mr. Barker speaks of, we find that, for example, the silver will vary from 1¼ ounces per ton in electrolytic copper down to a trace of four hundredths of an ounce per ton. The antimony, for example, will vary from four ten-thousandths of a percent up to fifteen ten-thousandths of a percent, and nickel for example, will vary from six ten-thous-

andths of a percent up to fifty-one ten-thousandths of a percent.

The oxygen in the coppers carrying ten thousandths of a percent of selenium, for example, will be up to .067 per cent, whereas, those which carry very small amounts of impurities will be down as low as .029 per cent of oxygen.

It has given us a very interesting picture, and there is a wide variation which we might expect in the recrystallization of the copper wire coming from these various sources.

Mr. Patterson: Is there any data available on continual annealing processes, that is the drawing and the annealing to apply it on smoothly?

Mr. Barker: Well, if there is, I would be very glad to see it.

Mr. Patterson: So would I.

Mr. Padowicz: With regard to the sticking of iron too high in a bell type furnace, have you any idea of what the best idea is of the process which would minimize this?

Mr. Barker: You are referring to the stickiness of wire which has been annealed in a dry atmosphere?

Mr. Padowicz: That is right.

Mr. Barker: We have found, unfortunately, that the cleaner the wire the more it sticks, or the greater the tendency to stick; and one of our departments is making a determined effort to get 100 per cent clean wire, so we have been having our problems with clean wire.

I can answer your question perhaps this way. In the case of 500 pound strander bobbins, which are quite a problem in that respect, we do not permit the outer turns to go above 375 degrees centigrade and we want the coldest part of the load to come to at least 325 degrees.

Mr. Padowicz: Do you control the furnace temperature to give you the thermal head grading there?

Mr. Barker: We do not make any effort to control the temperature of the gas. We let that find its own level. The furnace is on at full input until the thermo-couples in contact with the load itself reach the controlling temperature. The temperature gradient between the furnace atmosphere and the load during the greater part of the heating period is, therefore, higher than it would be if we held the temperature of the atmosphere at some fixed level and kept the furnace on until the temperature of the load approached this level. In other words, we believe that this system permits us to use the maximum rate of heating without running the danger of overheating any part of the load.

Mr. Padowicz: I see.

Mr. Barker: We have found this method of furnace control, using flexible thermo-couples, to be very effective in the annealing of strander wire. The problem with strander wire is to anneal soft enough to avoid ballooning on the strander and later difficulties with bend test on the finished cable and hard enough to have the wire reasonably free from stickiness. We have met these requirements very consistently since this type of control was installed.

Mr. Delray: Is there any particular part of the charge which you consider as the hot spot, or does that depend on the design of the furnace?

Mr. Barker: Well, it depends, of course, to some extent, on the design, but it depends more on the way you load the furnace.

You take a load of coils such as this (drawing sketch on blackboard). We have found that this coil here, about two coils down from the top, will cool more slowly than any of the rest. For this type of load, then, we place our recorder thermo-couple on the second or third coil down from the top. This permits us to uncover the load very close to the maximum safe temperature and thereby save time on the cooling cycle.

Mr. Delray: Well, in locating your thermo-couples, you must more or less make a guess throughout the charge?

Mr. Barker: That is what we have had to do in many cases. We have run tests on the various types of load representing the bulk of our production and we know definitely how the thermo-couples should be placed in these loads. If our guesses on the others do not get us into trouble, we assume that our guesses were correct. We believe that the flexible thermo-couples enable us to guess consistently, however, when we have to.

Mr. Delray: Have you experienced any trouble in over-shooting the mark at, say, 200 per cent?

Mr. Barker: Going over on the oxygen side?

Mr. Delray: Yes.

Mr. Barker: We have had some difficulty when we were running two atmosphere controllers together. At present we have only one analyzer, and with two atmosphere controllers running it is possible for one to be on the oxidizing side and the other on the reducing side without causing the analyzer to drop to zero. We are going to correct this by installing a second analyzer.

Mr. Delray: Well, how high would you consider your analyzers? A very small percentage, I suppose?

Mr. Barker: We have found this type of analyzer to be extremely sensitive. Variations which you could hardly see on an Orsat would cause the analyzer to swing up scale by several divisions. A variation of a half of a percent in CO would show up very prominently on the analyzer chart.

Meeting, Monday, October 17th, 1938 - 2:30 P. M.

Paper: "Chromium Copper Alloy Wire"

By C. H. Davis, Assistant Technical Manager,
American Brass Company, Waterbury, Conn.

(Paper Published in October, 1938 Issue of Wire and Wire Products - Page 565)

(A paper was read by Mr. C. H. Davis, American Brass Company, Waterbury, Conn., on "Chromium Copper Alloy Wire.")

— Discussion —

Chairman Bassett: Are there any questions, or any discussion that anyone would like to give here at this time?

Mr. Sherman: Mr. Davis what is the effect on the conductivity of cold work **after** the precipitation hardening treatment.

On page 568 of your paper in Wire & Wire Products starting line 3 it states, "The physical characteristics of the alloy are such" etc. It goes on and refers to fig. 2 and further states, "It is seen that the rods hard drawn **following** precipitation hardening have a higher conductivity than rods not drawn". Fig. 2, however, gives results on rods hard drawn **before** the hardening treatment. Table F gives the physical results of cold work after hardening but no mention is made there or elsewhere of the effect on the conductivity. As there is a marked increase in tensile properties, I was wondering if, as stated above, "rods hard drawn **following** precipitation hardening have a higher conductivity than rods not drawn" is correct.

Mr. Davis: I have a figure here but I am not sure that it answers your question, where the material has been homogenized before drawing. I was hoping that I had one showing material that had not been homogenized before drawing, but apparently I haven't one here.

Mr. Sherman: Well, do the conductivity values approximate those values here in the hard drawn state?

Mr. Davis: Yes, those do.

Chairman Bassett: Table F gives you those values, Mr. Sherman.

Mr. Davis: Does this figure "4" answer your question? The conductivity does not change appreciably by cold working. The conductivity is more or less fixed by homogenizing, but of course, it may vary slightly in the hard drawn alloy.

Chairman Bassett: If I understand your statement correctly, Mr. Davis, it is that probably the conductivity of all the rods referred to in table F, on page 567, are approximately the same?

Mr. Davis: Yes, the conductivity of the hard drawn rods that are drawn after heat treatment is very little affected by the cold working.

Chairman Bassett: Well, that was the point that he was bringing out, I believe.

Mr. Davis: Yes.

Mr. Rolle: I wonder whether Mr. Davis might tell us a little bit more in regard to the manufacture of the billet on which he has made his determina-

tions; in other words, under what conditions was the chromium added?

Mr. Davis: Well, I am afraid that I cannot be as frank as I would like to be.

As I have explained there are several processes revealed by patents in the United States Patent Office. We do not control any of those patents, but they indicate the proper method. If anyone will study them he will find that the published methods suggest the best practice.

Mr. Rolle: Well, I asked that question with rather a purpose, because we have been carrying on some experiments in the manufacture of alloys, in which we have been able to add elements, such as chromium, to copper, with no loss. I think as you point out, that the results you have obtained would constitute a ten per cent loss, and ten per cent and nothing is quite a wide range, naturally. Our own theories about that led us to believe that the percentage of oxygen in the bath has a great deal to do with the matter, and therefore, it would seem that further work on your alloys in which the chromium is added to an oxygen-free copper might give you some very interesting results.

Now, if I add your figures up here, in the analysis given on page 567, I get 99.8—that is, presuming that these are just very rough figures,—but even if you get the results up to 99.9, another one hundredth, you would still be short a tenth of a percent, and of course, with pure copper, that is an enormous amount. We are used to dealing with impurities in the third and fourth decimal place, and not in the second and first, so it would seem, with the preliminary work that we have done on alloys, that when the conditions arise, you can make an alloy which will arrive very close to 100 per cent, where there will be no oxygen present; so it would seem that further work on your part might develop some very interesting results.

Mr. Davis: Well, I quite agree with you, Mr. Rolle, that much more work should be done. I take it that your development is still in the experimental stage.

Unfortunately, chemists cannot get these alloys to add up to 100 percent.

Although we are very proud of our chemists in Waterbury, and have done this analysis over several times, we cannot say that the difference is one thing or another; but very likely some of the difference is due to the variation in the chromium content. As we have pointed out, with our lack of knowledge on having chromium properly and thoroughly distributed, there still remains a great deal of work to be done.

Mr. Rolle: Well, of course, your own figures where you say that you have a loss as high as 10 per cent of chromium added, immediately brings to mind that some of the chromium goes elsewhere than into the metal. Now, in other words, by making the balance between what you add and what you get into the metal the first consideration, I think the rest of it will work out by itself.

Mr. Gonser: I wanted to ask you if, in the course of your work, you noticed whether or not the chromium has much of an effect on the grain characteristics of the copper?

Mr. Davis: The control of grain is one of the problems of this alloy. It is controlled by having a surplus of chromium in the alloy itself. At high temperatures the chromium copper must be annealed very carefully, because it has a tendency to separate at the grain boundaries. As I recall it right now, we have an excess of one or two tenths of a percent chromium, theoretically, over the cheapest alloy.

Mr. Gonser: Well, if that alloy is taken back into that temperature, do you lose the properties there of the material? I have heard it rumored that you could reheat these alloys up to 550 centigrade, and still retain the properties of the original material. It doesn't seem proper, I know, but I have heard it said that you could actually reheat them and retain their properties, with reference to hardness.

Mr. Davis: Well, these four tables here indicate what might be expected, and the actual theory to follow is the general law that applies to precipitation hardened copper base alloys.

These alloys,—or rather, these percentages are recommended, and they do maintain certain qualities at higher temperatures. In all of our work to date we have found the alloys follow the general trend that is shown here in these tables and in these diagrams, the properties falling off at the higher temperatures. With varying degree, they begin to fall off in tensile strength at 500 degrees centigrade.

Chairman Bassett: Now, are there any further questions or remarks concerning this paper? If not, we will proceed to the next item on this program, which will be a moving picture.

(A motion picture on "Manufacture of Oil Filled Cable" by the General Electric Company, Schenectady, New York, was then shown.)

(Adjournment.)

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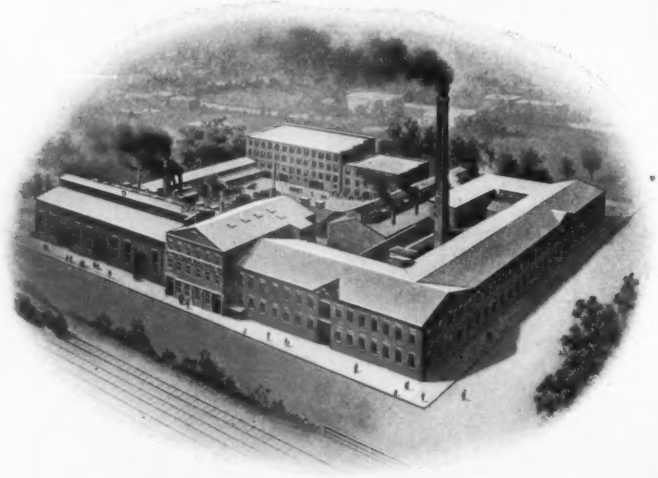

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NON-FERROUS DIVISION

Meeting, Tuesday, October 18, 1938 - 2:00 P. M.

Chairman of Meeting
W. H. Eastlake, Asst. General Superintendent,
Northern Electric Co., Montreal, Canada

PAPER: "HEATING COPPER WIRE BARS"

By J. A. Doyle, Vice President,
W. S. Rockwell Co., New York, N. Y.

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 571)

This Paper Received the 1938 Honorable Mention for the
Non-Ferrous Division

Editor's Note:

All copper men are likely to be interested by this discussion of Mr. Doyle's paper.

The concluding statement, in effect, is a comprehensive appraisal of the heating processes that so vitally affect quality; and an analysis of potential sources of inequality quite common throughout the industry.

Mr. Doyle's point of view, based on long, practical experience, is so diametrically opposed to prevalent opinion, as reflected by practice throughout the industry, that publication of the statement may mark a trend to significant changes, and a new conception of the influence of the several heating operations in an effort to meet the prevalent demand for higher standards of quality and uniformity.

(A paper on "Heating Copper Wire Bars" was read by Mr. J. A. Doyle, W. S. Rockwell Co., New York, N. Y.)

— Discussion —

Chairman Eastlake: Gentlemen, Mr. Doyle has agreed that it will be in order for any of you to ask questions or raise comments on the subject brought out by his paper.

In making your comments or in asking questions, will you please rise and give your name or associated company, or whatever institution you are associated with, so that our recording secretary may have a record of what takes place in this discussion?

The house is yours, gentlemen.

Mr. Barker: I believe that under Mr. Doyle's classification we would be listed as a consumer. In Schenectady we have observed over a period of several years that the hot rolled rod received from one rolling mill will be almost, well, I won't say 100 per cent free of rolled-in scale, but they will average very close to that. On the other hand, the rod received from another rolling mill will have such a quantity of rolled-in scale that we can't draw the rod on the same schedule with the other.

We have been told by one group of experts that the rolled-in scale can be controlled by observing certain procedures in handling the hot rolling of the wire, and another group of experts have told us that the rolled-in scale is essentially an act of God, and you have to take it; and it is for this reason that I am very much interested in what Mr. Doyle has said about the effect of the design and operation of the bar heating furnaces on the condition of the hot rolled rod.

I think that the rod mills with very few exceptions, have been very backward in adopting modern practice in heating wire bars.

Chairman Eastlake: Well, I would think that these comments call for some remarks from the rolling mill people, rather than from Mr. Doyle.

What is your feeling in the matter, Mr. Doyle? Do you want to reply to Mr. Barker's remarks, or do you prefer to hear from some of the rolling mill people?

Mr. Doyle: To start the ball rolling, I'll support Mr. Barker. His statement is sustained by practice altogether too common throughout the industry. The facts speak for themselves.

The problem is to find a remedy for an unfavorable condition that undoubtedly exists. It is not likely to be found, in my opinion, until the condition is studied perspectively, with due regard to the possible influence of prevalent heating practice in the refinery, heating for rolling, and in the subsequent annealing operations—all of which influence the structure and surface finish of the ultimate product.

Perhaps we can stimulate frank discussion of the ancestry of the skeleton in the family closet if I read the substance of a letter received from a wire mill executive just as I was about to leave New York to attend this meeting. I do not know the writer and have had no communication with him on the subject. It is an entirely gratuitous statement from his point of view, but it so timely and to the point that it may be in order to consider it. All names have been deleted to avoid embarrassment for everyone involved but myself. It is submitted in the nature of a sacrifice hit for the good of the game. The letter follows:

October 15, 1938.

Mr. J. A. Doyle, Vice Pres.,
W. S. Rockwell Company,
New York, N. Y.

Dear Sir:

I read with interest your article on "Heating Copper Wire Bars" appearing in October 1938 issue of WIRE AND WIRE PRODUCTS.

We purchase some finished copper wire in all sizes and various classes of insulation from the more prominent wire manufacturers and we also do some wire rolling and insulating ourselves.

We are constantly endeavoring to have our suppliers give us a better quality of copper wire and are particularly concerned with the quality of copper purchased for further cold working.

We have had the usual trouble with slivers, oxide inclusions, etc. as mentioned in your article. We find there is a wide difference in the quality of copper received from different manufacturers, principally "A", "B", "C" and "D".

We are particularly pushing the "D" company to give us a better product and they are considering basic changes in their processes which will require new annealing apparatus, which might be of interest to you. Of course, we realize that they are fabricators and not refiners.

If you have no objection in telling us, we should like to know which, if any, of the above mentioned companies do employ the modern type of heating at the refinery as described in your article "Heating Copper Wire Bars". This information would be kept strictly confidential and I am interested to see if the company giving us the best quality of copper do incorporate the process you describe, ————.

That, gentlemen, may be considered as an epistle from one of the lost tribe of customers wandering in the economic desert in search of the promised land of copper metallurgy.

I leave it to you to say whether or not it describes a condition that is more or less common in the industry. For reasons of state I shall not refer to any of the four concerns mentioned as each of them is represented at this meeting. (Laughter).

Please understand that the matter is referred to, not in a spirit of criticism, but in an earnest effort to encourage an attitude of facing the facts for whatever they may be. If, following Mr. Barker's statement, it discloses a condition more or less common, then the sensible thing to do is to get going in the direction of doing something about it. I am merely trying to do what little I can in an effort to throw light on the possible influence of the several heating operations on the condition we seek to correct.

Chairman Eastlake: Surely that ought to draw some fire from refiners and rollers.

Mr. Sherman: I think both the refiners and the rollers are all aware of the facts brought out by Mr. Doyle.

There is a trend in the refining practice in the introduction of the electric furnace and the vertical cast bar to help the refiners to take care of the points that Mr. Doyle has brought out in the refining end of the business.

The rod rollers have been more or less faced with the fact that the product that they receive is inherently bad, to begin with, that is, the standard horizontally cast bar, and I think their attitude has been more or less, "Well, why should we take such great pains to eliminate oxide on the outside of the rod, when there is considerable rolled in scale due to the bar," and there is also a trend away from the standard bar, which, I would say it is more conducive to good heating and rolling practice.

We are in the position of both rolling rod and drawing it, and supplying the customers with good drawn wire. We have found that the conditions in the rolling mill do affect the quality of the wire to a large extent, and we are now at the point where we can correlate the effects that we get in the wire mill with the effects that have happened in the rolling mill, and we can point our fingers almost without fail, as to just where the trouble has arisen.

Chairman Eastlake: Any rolling mill men?

Mr. Horsfall: I would like to get away from generalities, Mr. Chairman, and Mr. Doyle, and get down to one specific point. I would like to ask Mr. Doyle what his experience has been in respect to the scratching of wire bars on the water cooled or alloy rails? In talking with most rolling men, they don't deny that it is a condition that is existing in their furnaces, and I would like to ask Mr. Doyle what his suggestion would be to get away from it.

Mr. Doyle: A definite statement of experience to date with different forms of skid rails is included in the paper.

Alloy rails have not been found satisfactory for the reasons given. The present trend is toward improved practice with water cooled rails. It has been found in practice that much of the marking is due to accumulation of scale referred to in detail in the paper. It has also been found that better heating practice, which involves longer time for saturation, makes the bars softer and increases the tendency to marking. This phase of the problem has not been satisfactorily solved although efforts are being made to avoid it with different forms of rails.

Mr. Bassett: Before we go any farther, I would like to know what you did about that unsolicited letter?

Mr. Doyle: The reply was in the nature of a personal opinion not intended for this meeting. However, if you insist, I will hand out the naked truth.

Chairman Eastlake: Well, the question is before the house, and I think it is in order for you to state your reply to it.

Mr. Doyle: The substance of the reply is included in the following statement:

To the best of my knowledge, most refineries do not, in practice, apply **throughout** the melting process the fundamentals of heating that they insist are essential for properly heating wire bars, and for the subsequent annealing operations. There are exceptions but the practice is not common.

Statement of experience of men intimately acquainted with heating practice in every copper center throughout the world indicates that, at least, it is not common practice.

The unfavorable situation is, in my judgment, the result of tradition responsible for a method of production on a large scale in the plant that is logically out of step with the relatively small scale experimental process in the laboratory. In the latter we determine what the customer ought to have, but it is the plant that determines what he actually does get.

It has been stated that my point of view is likely to be questioned on the ground that it is unreasonable to assume that fundamentals have been overlooked by the wealth of technical talent that has studied the problem at close range. Nevertheless, the condition is so prevalent, and the cause of much of it so obvious, that I feel it is about time someone had courage to say so out loud in the hope of encouraging better practice for the good of the industry.

Ultimately, the customer will compel a change if the industry does not do what it should have done long ago as a matter of course.

Chairman Eastlake: All right, gentlemen, there you are.

Mr. Rolle: Before making any detail-comments on Mr. Doyle's very excellent paper, I think we should thank and congratulate him for his contribution to our knowledge of the subject. He deserves a great deal of credit for bringing this important subject out into the open.

As a modest representative of one of the copper refineries, I should like to divide Mr. Doyle's paper into two parts and then take issue with his views on one of them.

I do not think the problems involved in heating wire bars preparatory to hot rolling, and melting cathodes, can properly be lumped together even though both are carried out in fuel-fired furnaces.

Let us first consider furnaces for melting copper. It has been my experience that many refineries, including our own, already do many things recommended by Mr. Doyle. Our reverberatory furnaces used in the production of tough pitch copper are constructed and equipped so as to control the rate of combustion and the temperature, but without using too complicated mechanism.

In the production of our oxygen-free copper we go a great deal farther than Mr. Doyle suggests. We not only exercise precise control of the atmosphere and temperature of the copper during melting, but maintain this control after the metal leaves the furnace up to the time it solidifies in the molds. Therefore, I think it is important that we keep in mind the difference between the design, construction, and operation of furnaces used in melting copper, and furnaces for Heating Copper Wire Bars, the title of Mr. Doyle's paper. So now let us turn to this part of the subject.

Our company produces copper only in cast form and has no facilities for fabricating. Consequently, I really have little right to criticize the operation of copper rolling mills. However, I am sure that I will be pardoned for saying that a few of the mills have been somewhat backward in improving their heating practice. On the other hand, I feel certain that all of them are fully aware of the problem although they may not fully realize its importance. I know that a number of them have already done what Mr. Doyle has recommended and others are about to do so. Some of the mills may be far ahead of Mr. Doyle and others may be a bit slow for reasons that perhaps should not be mentioned here.

Speaking merely as one connected with the copper industry, I believe that the customer, the fellow who buys the products of the rod and wire mills, is largely to blame for the reluctance of the mills to make costly improvements. If there are any customers present, I think they will admit here and now that they often demand a great deal in the way of quality but at the same time are unwilling to pay for this extra quality.

Now it is quite true that if competition is keen enough, the improvements demanded are ultimately made. The seller hopes the customer will pay for them and vice versa, but the important part is that the customer must show a real interest in the problem and not merely make demands without explaining why.

It has been my experience that when a customer does show this interest and discusses his problems freely with the supplier or producer, and above all indicates his willingness to pay something additional for a better product, many producers will be glad to cooperate and at least meet the customer half way. But so often the customer does nothing more than make demands and just as soon as he hears that he must pay a fraction of a cent more per pound for the product he is buying, he throws up his hands in horror. We shouldn't be too hard on the sellers, whether they be refineries or mills, if they show little or no interest in demands made by customers of this sort.

Now we metallurgists are quite often not consulted about matters of this sort and they are allowed to remain in the hands of the Sales Engineer on the one hand, and the Purchasing Agent, on the other. But sometimes we are consulted and even requested to make recommendations to the executives. Then we are asked, and rightly so,—"Who is going to pay for this improvement you are recommending us to make?" And if we cannot demonstrate that it is all to be paid for by the customer, the improvement is side-tracked regardless of its metallurgical importance. And it should be sidetracked or even completely abandoned if we as technical men stop right there and do no more.

Mr. Doyle has presented his case most plausibly. His language is most persuasive; in fact, I think he could convince anyone of anything but I am afraid the problem is not as simple as he would have us believe. I say this not derogatorily but merely to emphasize the point I am trying to bring out, namely, the necessity for all of us metallurgists and engineers to preach the gospel of better quality not only in our own works and offices, but among our customers and other people with whom we come into contact. We must educate the trade to

demand better quality and be prepared to pay for it. In some cases we shall find this very difficult and in others quite simple. I, myself, have run into customers who are prepared to pay substantial premiums to get better quality and the task of education is comparatively easy. But in most cases it is slow, tedious work and we must spend what sometimes seems to be endless time in this educational work before we even get a start. And here we come to another problem, namely, that of correct approach.

Talking from personal experience, I can say definitely that often we get nowhere in our sales promotion because we have tackled the wrong man. Take, for example, Mr. Doyle's recommendation for better heating practice—I am wondering how many users of copper rod and wire are aware of the problem he has discussed here today. A few, no doubt, but on the whole I believe they are not very well informed about matters of this sort. That is why I think we have made such a good start here today in bringing a problem of this sort out into the open. It is up to us as metallurgists and engineers of producers to educate the purchasing agents, as well as the metallurgists of customers by telling them about better methods of production and in this way create a real demand for superior products. If we all did this, Mr. Doyle's job would be easier and we in turn as representatives of the producers might benefit by his success in convincing the mills of the necessity for better methods of heating.

Again, I think this group owes a vote of thanks to Mr. Doyle for his excellent paper and his further remarks on the subject.

Mr. Doyle: Commenting on the kindly statement of Mr. Rolle—part of the present task is to attempt to do here something that I verily believe must be done for the good of the industry; and that I failed to do—in the plants—in more than twenty years of effort which, as some of you know, has not been of a pussyfooting nature.

Coaxing the industry to sense the obvious error of its way of heating is as futile as an attempt to cross notions of the "New Delirium" with facts of economic experience. We change when we have to—not when we should. The tail of production wags the metallurgical dog.

It is time to crash through the mental inertia that maintains poor average heating practice responsible for much of our difficulty; and, come what may, prod the industry to do what it should do as a matter of course; educate the customer with better metal—before it is compelled to do so by customer demand and the competition of other metals.

Scope of the paper is justified by the belief that the man drawing or using wire—and having trouble with it—is entitled to information on **all** the probable causes—even though they may direct inquiry on the possible metallurgically syphilitic nature of the metal itself; or improper annealing by the fabricator.

The statement of Mr. Barker, Mr. Sherman, the writer of the anonymous letter, and others not heard from, indicate to my mind that it is the customer, and competitor, who are educating the industry to the need for better metal; and that there is substantial evidence to support the belief that the industry at large is not in a position to deliver the goods.

Further evidence of growing demand is indicated by the paper—"The Need of a Better Quality of Copper in Apparatus Manufacture" read at the 1937 meeting of this association.

I agree we should educate the customer to pay a reasonable price for better quality; but, you all should agree it is apparent that there are potential customers hunting for that better quality. The irony of the situation is that most of us have to educate ourselves to better heating habits before we can logically hope to teach the customer better buying habits.

Reformation is, admittedly, not a simple task, largely because of mental momentum of the past—mostly in the plant; but, I contend, possibility of improvement is based on principles so simple and obvious that the industry is properly under technical indictment for its Bourbon-like failure to recognize and adopt them.

Regardless of whether the cause lies in the refinery, rolling mill, or annealing, the evidence is that many complain of difficulty in procuring desired quality and uniformity; and that heating operations are potential sources of the difficulty.

Metallurgical interdependence of the several heating operations is not generally sensed. The fact of its existence justifies an effort to encourage metallurgical control of **all** factors common to the heating operations that materially influence quality. The refinery has its share of responsibility, but it is too often blamed for a condition set up in the rolling mill; and either, or both, are held responsible for irregularities actually established by the fabricator in annealing.

As responsibility cannot be determined arbitrarily, it seems sensible to consider **all** at one time in an effort to separate the guilty goat from the virtuous metallurgical sheep in the process of passing the buck.

Defense of the point of view rests on these factors:

1. Variable results in practice indicate need for improvement.

2. Unfavorable results — in quality and uniformity — are frequently logical consequences of ineffective and outmoded methods of heating—in melting, rolling and annealing — that have too long outlived their usefulness—if any.

3. A constructive change in heating practice is long overdue because:

(a) Heat has more influence on quality than any operation in production or fabrication.

(b) Average practice obviously disregards fundamentals of heat application, the economic value of which is conclusively demonstrated in other operations, and other industries, affected by the same fundamentals.

(c) The customer demands it.

(d) Competition, fostered by technical development, will force it eventually.

(e) The prevalent situation, in effect, reflects more in the form of a traditional state of mind—in the plants—than the reasoned conclusions of metallurgists who have done such admirable work in developing new fields of usefulness, which is the economic foundation of the industry.

One attempting to support a contrary view, as have too many for too long a time, is confronted with the difficult task of logically explaining how it is possible to overcome the effect of natural laws that go into play when he opens or closes a door covering the chamber;

or, when the weight or mass of the charge of cold metal varies materially;

or, when burners alternately blast against a pile of solid metal at one end of the chamber and subsequently over a molten bath;

or, when the input of air is not varied with the input of fuel;

or, to avoid contaminating hot metal in direct contact with a blast of unburned air and fuel;

or, to maintain uniform atmosphere throughout the chamber unless it is substantially filled with gases of reasonably uniform composition;

or, when there is involved in the operation a substantial number of factors subsequently referred to as possible sources of contamination.

Until such conditions are avoided it is logical to assume that the heating practice is not what it should be; or that it reasonably approaches standards established for other heating operations that have less influence on quality.

The fact that it is common practice to attempt to remove from the molten metal impurities that did not exist in the metal as charged, in the form of cathodes or otherwise, indicates contamination in the melting process. An effective way to deal with such impurities is to avoid—as far as may be practical, unfavorable conditions that make them possible. If they are not introduced, it is unnecessary to remove them.

Certainly, there is marked contrast between average methods of melting, heating for rolling, and those established for annealing copper wire, tubes, sheets, etc.—uniformly and without oxidation—in the open chamber of fuel fired furnaces—without muffles or special gas generators to avoid oxidizing conditions that are not permitted to exist.

While it is admittedly unreasonable to expect to duplicate such practice in melting or rolling, it is **not** unreasonable to assume that the very wide latitude affords opportunity for substantial improvement.

The development to which Mr. Rolle refers indicates the need, and possibility, of improvement as a means to the end of better quality which justifies a reasonable price.

Development of the coalescence process, by a prominent producer, that avoids the melting and hot rolling operation, is another indication of recognition of their influence on quality and uniformity.

Sources of contamination in the melting process—many of which can be avoided—include:

1. Uncontrolled infiltration of air through:

(a) Uncovered burner openings.

(b) Working openings when uncover- for charging, stirring or poling.

(c) Open space around loose fitting doors.

(d) Uncovered peepholes.

2. Changing volume, temperature, composition, or pressure, of gases in the melting chamber due to variation in fir-

ing; or irregular infiltration of air; or variation in weight and mass of solid metal in charging.

3. Unburned gases blasting against a pile of metal in process of melting.

4. Variation in atmosphere due to change in input of fuel without corresponding change in volume of air.

5. Irregular firing due to uneven pressure or contamination of fuel.

6. Improper damper operation which should vary with the firing requirements.

7. Variable draft from stack.

8. Sulphur in fuel.

9. Refractory particles from spalled sections of chamber caused by alternate heating and cooling.

10. Oxides from stirring rods.

11. Oxidation of hot stream of metal when pouring.

12. Oxidation of exposed surfaces of the casting which varies with form of mold.

13. Incompetent operatives.

14. Uneven poling throughout the bath.

Sources of contamination in heating for rolling are definitely stated in the paper.

Attention is directed to the unlucky thirteenth, which represents a penny wise, pound foolish, practice in most heating operations throughout the industry in which the "human element" is a controlling factor. The price the industry has paid for this folly is astounding.

It might be well to reverse the orthodox plant practice by transferring some of the boys from the laboratory to the furnaces, and some of the furnace crew to the laboratory. This would have the profitable effect of getting rid of ineffective heaters; and sweating out of cub metallurgists some of the nonsense of cumulative error acquired from a book written by one who read some other books; but never experienced the soul stirring thrill of attempting to produce uniform metal with heating methods that defeat the purpose and maintained contrary to the laws of God or nature—as the case may be.

The man at the fire is **the** forgotten man in industrial heating practice; yet, he is the cause of much grief of the sales department.

While I marvel at the skill with which the industry has devised machinery for forming wire, I cannot understand why such obvious conditions have so long been disregarded by the wealth of technical talent available; especially when they are part and parcel of the practice of every good cook in the application of principles that apply with equal force in application of heat to metal.

Possibility of avoiding similar conditions in annealing is conclusively proved by installations producing uniform bright annealed metal—without scale or pickling—at much less cost, in much less time, and with less complaint from the customer.

However, most metal produced today is not properly annealed; partly because of conditions previously referred to; and, further, because the mills persist in the old mediaeval custom of heating—and cooling—large closely packed batches in the erroneous belief that expensive forms of heat energy, automatic temperature control, and uniform pyrometer charts, are evidence of uniform annealing.

The ancients that sacrificed a goat to appease the wrath of the gods, as a means to the end of producing uniform metal, are the technical ancestors of the moderns who offer a pyrometer record to appease the wrath of the customer who refuses to be a goat in the belief that evidence of uniform temperature on the chart offsets proof of imperfection in the metal itself.

We must sense the distinction between mere thermal technology and basic principles governing application of heat. It is still a fact that one cannot cook pancakes six high on a griddle and get them all alike. As might be recorded in the lamentations of the Jeremiahs of the copper industry—What doth it profit a cook to automatically maintain a uniform temperature in a well insulated oven—"if the biscuits ain't fit to eat?"

The mills are getting around to that fundamental fact—now gray with age. The customer is being educated to possibilities of better metal—**by men outside the industry**—and has forced from without a reform that could not be induced from within. They reformed, as will the others, when compelled to—**by the customer,** who is now about to throw a party for the boys in the refinery and the rolling mill. The prospects for a "Donnybrook Fair" are intriguing because they are so obviously pregnant with a variety of possibilities for a series of intermittent intellectual miscarriages.

In conclusion, the substance of this statement is to encourage thought of possibility of dealing with the cause, in order to control the effect, of contaminations established in the several heating processes.

I am less concerned about the technical possibility of effecting improvement than the state of mind that has so long resisted it. There is as much psychology as technology in the problem.

It can be done—if, as and when the metallurgist is afforded the mental freedom to survey the problem in perspective; to consider it, basically, as it should be—not traditionally, as it always has been; and to study it, objectively, in light of the facts, with an open mind—not open at both ends for free flow of plant tradition, and restraining influence of the pontificial attitude of mind that has too long dictated unsound heating practice in melting, rolling and annealing operations that so vitally affect quality and uniformity of the ultimate product.

Perhaps the atmosphere of this technical meeting—free from traditional precedent and restraining commercial factors, may develop a broader vision of attractive possibilities for better results. (Applause).

Chairman Eastlake: I think we all have a lot to thank Mr. Doyle for. Mr. Rolle has already made a motion of thanks. Every copper man has something to think about after this discussion.

Meeting, Tuesday, October 18, 1938 - 2:00 P. M.

PAPER: "ALUMINUM COATED STEEL WIRE"

Dr. Colin G. Fink, Head Division of Electrochemistry,
Columbia University, New York City

(Paper Published in October, 1938 issue of Wire & Wire Products - Page 579)

(A paper was read by Dr. Colin G. Fink, Columbia University, New York City, entitled "Aluminum Coated Steel Wire.")

— Discussion —

Dr. Fink: Mr. Chairman, I think I have gone over this a little hurriedly, but I will be only too glad to answer questions, if any.

Chairman Eastlake: Gentlemen, you have heard Dr. Fink's paper, and you have heard his offer to answer questions, I think they are in order and I believe there are many of you who have some questions to ask.

Dr. Fink: Well, Mr. Chairman, I think you have put me in a somewhat unfair position, because the paper discusses steel wire, which is a ferrous proposition and this is a non-ferrous meeting.

Mr. Wickwire: Do you have an exclusive license on your process to any one manufacturer, or are you going to license it generally?

Dr. Fink: The Reynolds Metal Company, of Knoxville, Tennessee has the American rights, and they sub-license others.

Mr. Rolle: I should like to ask the professor what carbon content of the steel does he recommend to be used.

Dr. Fink: We have used quite a range, 20 carbon, 40, 60, 80; but whatever the carbon content is, the contact surface of the wire is practically always the same, that is, the aluminum comes into contact with practically pure ferrite.

Unidentified Voice: What is the thickness of the tubing, and how can you control the tubing?

Dr. Fink: By regulating the speed of travel and the temperature of the aluminum bath. In a number of cases, a wiper is used as it is in the case of galvanized wire, so that you can get your coating down to an extremely thin layer.

The German licensee is particularly interested in an aluminum-coated sheet for cans. For a fireproof screen, we prefer a relatively heavy deposit of three to five mils.

Of course, remember that aluminum has a specific gravity of 2.7, a whole lot lower than that of most other metals we usually deal with.

Mr. Whitney: I believe that Dr. Fink should be congratulated on the development of this process which forms an important contribution to the corrosion and oxidation resistant materials now available.

From Dr. Fink's talk, I understand

that the preparation of the steel surface is extremely important. Even under these conditions, with thin coatings of three, four, five or six zeros, I should like to inquire about the possibility of pin-holes being present in the coating. Of course, we know that, when pin-holes are present in a galvanized sheet, the zinc will exert a certain amount of sacrificial protection for the steel base. If, however, the same pin-holes occur in a tin coated material, the tin will not offer any similar protection to the exposed steel and, as a result, corrosion will take place in those areas. From its position in the electrochemical series, aluminum would be expected to offer sacrificial protection to steel, in the same manner as would zinc. When we expose aluminum to the atmosphere, however, it immediately takes on an oxide coating so that the galvanic cell set up at the pin-hole would be between aluminum oxide and steel and not between aluminum and steel. This, I believe, would change the picture considerably in regard to the protection of the steel in exposed areas. I should like to ask Dr. Fink just what effect pin-holes in the aluminum coating would have on the corrosion properties of the material.

Dr. Fink: We were very much surprised in seeing how some of these samples behaved when set up and tested. There were two fortunate circumstances that entered:

First, if you examine the cross section of the wire, you see the steel core, and then the aluminum-iron bond, and then outside of this a thin coat of aluminum. If you look at this wire which has operated at 1000° C. you can see that the wire is black, compared to the other new sample which is silver-white and yet in the case of the heated wire you still have your aluminum-iron alloy. Once in a while we do have a bad break. Fortunately we do not get bad breaks very often. It is very difficult to get a defective spot in the wire, due to the way it is made, for example, the "cleaning" operation in the hydrogen furnace is much better than any other cleaning operation you can think of. Then, too, the aluminum-iron alloy is much more insoluble or much more corrosion-resistant than the aluminum or iron alone, and then, lastly, the corrosion product itself, hydrated aluminum oxide, is insoluble in rain water, whereas in the case of zinc it is soluble and washed away by rain water. In the case of aluminum it remains on the surface and protects it against further attack.

Now, we call zinc a sacrificial metal, as in a galvanized fence wire or poultry wire, it will last just as long as the zinc lasts, and as soon as the zinc or zinc oxide is washed off the wire deteriorates rapidly. In strong contrast to zinc, the rain water does not wash away the aluminum coating.

Mr. Elder: I would like to ask Dr. Fink, on say No. 10 size, .135 inch diameter wire, how heavy an aluminum coating by this process he has been able to put on, expressing it in thousandths of an inch?

Dr. Fink: We can put on 2 mils, 3 mils, 5 mils, and so on, depending on the way the coating is applied. With the special anneal we can give it an extra coating. As to the spangled effects, these are very much like those in heavy galvanized products.

A Member: Well, how does it stand up under sulphur, in the atmosphere of coal gas?

Dr. Fink: Well now, you are playing right into my hands. Have you ever seen aluminum sulphide?

A Member: No.

Dr. Fink: Well, it does exist. You can make aluminum sulphide in a special furnace, but it is pretty hard to form, that is, as compared with iron sulphide or zinc sulphide.

Mr. Granger: I was very much interested in your statement, Dr. Fink, regarding the corrosion resistant of the aluminum iron alloy.

Now, where the view was shown on your scene it seemed to have rusted. Now, these samples were thrown in the atmosphere, and they seemed to be rather badly rusted, I notice.

Dr. Fink: Were they my samples?

Mr. Granger: Yes, they were.

Mr. Fink: If you do not clean your steel surface properly, or you have too heavy a scale on the steel wire, or you have wire with fins in it, or something of that kind, then in a very short time you will note rust or corrosion.

Or, if the wire travels too fast, say 400 feet a minute, why, you can adjust the speed so that you almost do not get any coating at all. We have run a large number of comparative tests with the various coated metals, and although the aluminum will discolor after six months or nine months, that is, it will turn dark, it will nevertheless hold its own and last a long time. Whereas the zinc will remain fairly bright as long as there is any zinc. After all, we are all interested in the complete failure of the coated wire at any point.

Mr. Pierson: Dr. Fink, would you expect difficulties in the maintaining of the carbon content of a fine wire, say fourteen thousandths diameter wire, say at sixty-five to seventy hundredths per cent carbon, and still maintain that and get an aluminum coating on that?

Dr. Fink: Well, I think you can answer that better than I can. Of course, when your wires get so thin, then the surface is so much greater than the cross section. You have too much surface, and in the hydrogen furnace your heating and decarburization is almost instantaneous.

My recommendation in your case would be aluminum-coating the wire 5 or 10 times the diameter and then draw down to size after coating.

Mr. Pierson: Could you put it through the regular drawing operation?

Dr. Fink: Oh, yes. We have taken samples 1/8 inch in diameter and drawn them down to fly-screen size. Even for fly-screen you do not want a soft wire; you want a certain amount of stiffness.

Mr. Pierson: Well, the wire I am thinking of must have a certain temper, and I was wondering if you could manipulate it through all the drawing operations you have described without damaging the aluminum coating.

Dr. Fink: Yes.

Mr. Pierson: Well, in order to maintain a sufficiently thick coating of aluminum, to give it any appreciable protection at a diameter of, say, fourteen thousandths you would have to coat it at some size not very far above that?

Dr. Fink: No, we can go fairly high in diameter.

Mr. Pierson: You could?

Dr. Fink: Yes; and with the special second heat treatment, the three layers draw down very nicely. They did not at first, though, I will say that.

Mr. Klonkie: What temperature is maintained in the aluminum bath?

Dr. Fink: Well, you are treading on too ticklish ground now. Perhaps we had better not discuss that point.

Mr. Klonkie: Is there any possibility of using the bath as a final source of heat?

Dr. Fink: Oh, yes, I think it would.

Chairman Eastlake: Now, gentlemen, I think that we all should extend to Professor Fink our vote of thanks for his excellent paper.

Mr. Westphal: Mr. Chairman, as President of the Wire Association, on behalf of the members of the Wire Association, I wish to extend to Professor Fink our appreciation for his efforts in coming all the way from New York to give us this wonderful paper, and I am sure that all the members join in this appreciation; and I wish personally to extend the thanks of the Association, as President, to Professor Fink. (Applause.)

Meeting, Tuesday, October 18, 1938 - 2:00 P. M.

PAPER: "THE DEVELOPMENT OF HIGH- STRENGTH ELECTRICAL CONDUCTORS AND MESSENGER CABLES"

By C. H. Davis, Assistant Technical Director
and Ira T. Hook, Research Engineer,
American Brass Company, Waterbury, Conn.

(Paper Published in November, 1938 issue of Wire & Wire Products - Page 665)

(A paper was then read by Mr. C. H. Davis, Assistant Technical Manager, American Brass Company, Waterbury, Conn., entitled "Development of High Strength Electrical Conductors and Messenger Cable.")

— Discussion —

Mr. Davis: I believe that is enough at this time. When the paper is printed the details will be more easily available.

Chairman Eastlake: Well, don't you think what you have given us is sufficient for some discussion? This abstract of the paper read, by Mr. Davis and his colleague, Mr. Hook, I think calls for some discussion by the wire people.

Mr. Morris: I think I can add a little something to the historical part of the paper.

Prior to 1922, as a result of work carried on in our laboratories, we put on the market a high strength messenger cable that contained a combination of tin and silicon. That was known as Phono-High Strength. I think that is of interest because I think it was the first wire cable of real silicon bronze, that is, one containing tin and at the same time silicon as one of its major constituents.

Chairman Eastlake: Any more questions or comments? Have you anything to add, Mr. Bassett?

Mr. Bassett: Mr. Morris correctly brings out that probably the first copper tin silicon messenger cable used was the Phono-High Strength. At the same time that his company was bringing out this alloy, we did find that the Dupont Company were interesting other manufacturers in the use of their copper silicon manganese alloy, which they developed during the war to take care of acid requirements.

Later on, this was used by the American Brass Company.

Chairman Eastlake: Well, can you give us some information about drawing this alloy? I think some of the people must be interested in this.

Mr. Bassett: The alloy is a hot working alloy. It is handled in much the same way that a copper wire bar is handled. It is cast in a 3¼ square end bar, and then it is hot rolled to normal size of a hot rolled rod. It is pickled in the same way that the copper and wire rod is handled, but on account of the aluminum oxide on the surface of the wire, it has to be given a special cleaning operation to remove the aluminum oxide from the surface of the rod, which would otherwise cause difficulty in the drawing of the wire. When the aluminum oxide is removed from the surface of the rod it is drawn in the same way that we handle the copper wire rod.

Chairman Eastlake: I see. Have we any other comments or questions?

Well, I think the Wire Association also owes its thanks to Mr. Davis and his associate, for coming here to tell us this story. I think it is a pity it hasn't been reprinted, because I think it would be open to discussion here.

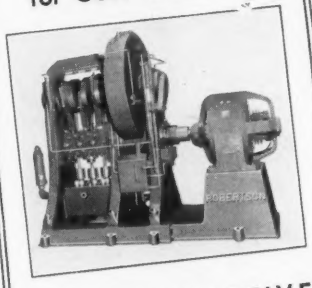
Well, gentlemen, if there is nothing further, we will now adjourn.

(Adjournment.)

The date of the Annual Wire Association Convention for 1939 has been changed from October 16th to that of October 23rd to 27th inclusive. Please note this change in making your plans to attend.

For Information
Regarding
The Wire Association
Address
Richard E. Brown, Secretary
17 E. 42nd St., New York, N. Y.

THE ROBERTSON
HIGH PRESSURE PUMP
for Cost Reduction



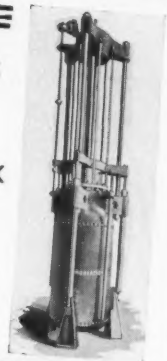
14 DISTINCTIVE CONSTRUCTION FEATURES

The Robertson Hydraulic Pump costs less to run and maintain, and THIS must be borne in mind when *first costs* are considered. You pay slightly more for the Robertson pump, but in the long run you pay less, for you are buying a design that is definitely "the last word" . . . 14 separate features make this pump what it is, *and we invite you to compare these features with any other pump you may have in mind.*

Write for Latest Bulletin.

THE MOST
COMPACT
UNIT OBTAINABLE

UTILIZES ITS AIR TANK AS A BASE



Far easier to install than most and requiring much less space . . . this thoroughly modern Accumulator *utilizes its air tank as a base,* requires no special heavy foundation. Equipped with an automatic auxiliary air compressor which maintains pressure in cylinder and storage tanks . . . operating on but 175 lbs. air pressure . . . it will give long, trouble-free service and consistently economical performance.

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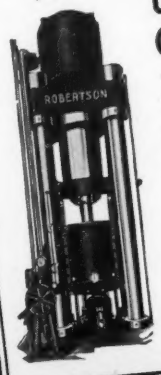
FOR UNIFORM CABLE SHEATH



These Presses have encased thousands upon thousands of miles of cable with lead sheath, at same dependable rate of production, and with the same low operating and maintenance costs.

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PRODUCTS OF
JOHN ROBERTSON COMPANY, INC.
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Outstanding Personalities of the Wire Industry

J. E. TIMBERLAKE
Manager of Wire Sales
Jones & Laughlin Steel Corp.

A. W. Herron and J. E. Timberlake

THE appointment of A. W. Herron, Jr., as Manager of Warehouse Sales has been announced by the Jones & Laughlin Steel Corporation. He has been Manager of Wire Sales since 1935, and prior to that had been District Sales Manager at Cincinnati for a number of years.

✦ ✦ ✦

MR. HERRON is succeeded as Manager of Wire Sales by J. E. Timberlake, who started with Jones & Laughlin in 1919 and has been in the Wire Sales Department since 1925.

✦ ✦ ✦

L. C. Crewe

MR. L. C. CREWE, recently appointed Assistant Superintendent of the Rod and Wire Mill, of the Bethlehem Steel Company, Sparrows Point, Maryland, graduated from Lehigh University as a Metallurgical Engineer, and went to Sparrows Point well equipped with the working knowledge of the blast furnace and of steel making.

✦ ✦ ✦

AFTER two years in open hearth work, he was transferred to the Wire Mill in 1933, to assist in the development work on the Bethanizing Process.

✦ ✦ ✦

IN 1934, Mr. Crewe was made Foreman of the Bethanizing and Galvanizing Departments, and later took charge of the Barbed Wire and Bale Tie Departments. He was promoted to General Foreman in 1936, and in September of 1938, became Assistant Superintendent.

✦ ✦ ✦

J. Carlton Ward, Jr., Vice-President, United Aircraft Corporation, New York

TO many members of The Wire Association, the announcement that Mr. J. Carlton Ward has been appointed Vice-President and a Director, United Aircraft Corporation, New York, and General Manager of the Pratt & Whitney Aircraft Division of the company at East Hartford, Connecticut, will be interesting.

✦ ✦ ✦

L. C. CREWE
Assistant Superintendent, Rod and Wire Mill
Bethlehem Steel Company,
Sparrows Point, Maryland

A. W. HERRON,
Manager of Warehouse Sales
Jones & Laughlin Steel Corp.

MR. WARD spent many years in the wire industry, as General Works Manager of the General Cable Corporation, during which time he was a member of The Wire Association, and at one time, Vice-President of the organization.

✦ ✦ ✦

OUR best wishes go to him in connection with his promotion to Vice-President.

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V. H. Dearle

MR. V. H. DEARLE has been appointed Assistant Detroit District Manager by the Carboloy Co., Inc. Mr. Dearle has been with the company since its formation in 1928. He is a charter member of the American Society of Tool Engineers and has been connected with the tool industry in Detroit for over 30 years in executive capacities in automobile plants, refrigeration plants and tool companies.

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Exports and Imports of Wire

Exports of Iron and Steel Wire Products in Oct., 1938 and Oct., 1937
(In gross tons)

	OCT. 1938	SEPT. 1938	OCT. 1937
Wire rods	1,232	508	7,182
Strip steel	6,121	5,619	7,885
Plain, black or galvanized iron or steel wire	5,124	5,073	4,568
Barbed wire and woven wire fencing	4,417	4,923	2,994
Woven wire screen cloth	124	96	111
Wire rope	235	218	486
Insulated iron or steel wire and cable—see analysis below			
Other wire and manufactures	428	460	680
Wire nails	2,040	1,974	704
Tacks	36	47	41
Other nails, including staples	351	414	279
Bolts, machine screws, nuts, rivets and washers	674	625	937
Total, these 11 classifications	20,782	19,957	25,867

Imports of Iron and Steel Wire into the United States
(In gross tons)

Concrete Reinforcement bars	86	105	14
Hollow bar and drill steel	79	72	295
Wire rods	415	564	1,282
Barbed wire	973	671	2,367
Round iron and steel wire	199	167	308
Telephone and telegraph wire	2	1	1
Flat wire and strip steel	243	180	288
Wire rope and strand	162	214	309
Other wire	114	49	99
Hoops and bands	1,079	922	1,310
Nails, tacks and staples	414	739	1,010
Bolts, nuts and rivets	30	62	69
Total, these 12 classifications	3,796	3,746	7,352

Exports of Insulated Wire and Cable, October, 1938

	Foreign		To U. S. Possessions	
	Pounds	Dollars	Pounds	Dollars
Rubber covered wire	422,143	$100,544	130,777	$ 26,136
Weatherproof wire	306,501	42,551	9,429	2,517
Other insulated copper wire	489,172	96,737	98,938	13,733
Nickel-chrome electric resistance wire	61,509	73,428	.....	.....
Total these 4 classifications	1,279,325	$313,260	239,144	$ 42,386

RECEIPTS of iron and steel products (scrap excluded) amounted to 20,921 tons valued at $1,300,714 in comparison with 23,740 tons valued at $1,332,035 in September and 29,502 tons valued at $1,743,474 in October, 1937. Total imports during the first 10 months of 1938 amounted to 194,974 tons valued at $12,193,206 against 402,431 tons valued at $21,280,294 in the equivalent months of last year.

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THE outstanding product shipped in October (from the standpoint of tonnage) was pig iron with 61,339 tons in comparison with 66,600 tons in the preceding month and 66,297 tons in the corresponding month of 1937. The outstanding markets were Japan, 48,637 tons; Italy, 6,174 tons; and Germany, 5,000 tons. Next in importance, plate had a 19,743-ton total against 10,752 tons and 59,088 tons and, in a widespread trade, was taken principally by the Netherlands, 7,981 tons; Canada, 1,589 tons; and Sweden, 960 tons. Following came black steel sheets with 14,427 tons against 16,610 tons and 27,396 tons and here, too, many markets were reached, those outstanding being Canada, 4,358 tons; the United Kingdom, 2,751 tons; the Soviet Union, 1,407 tons; and Australia, 930 tons.

✦ ✦ ✦

EXPORTS of scrap in October totaled 223,954 tons valued at $3,238,232 in comparison with 149,673 tons valued at $2,093,925 in the preceding month and 185,618 tons valued at $3,284,109 in the like month of last year. In the first 10 months the volume was 2,406,392 tons valued at $37,094,233 against 3,517,508 tons valued at $69,249,545 last year. The outstanding scrap purchasers during the first 10 months of 1938 (with comparative figures for 1937 and 1936) are named below:

✦ ✦ ✦

JAPAN in October took 53,824 tons of iron and steel products (scrap excluded) from the United States, and the principal items were pig iron 48,637 tons; steel bars, 1,677 tons; steel ingots, etc., 1,667 tons; and plate, 866 tons. Canada followed with 32,251 tons of chiefly skelp, 13,817 tons; black steel sheets, 4,358 tons; strip steel, 2,645 tons; shapes, 2,081 tons; and steel bars, 1,709 tons. Then came the Philippine Islands with 12,768 tons of, chiefly, steel bars, 3,599 tons; galvanized sheets, 3,016 tons; and tin plate, 2,110 tons. Fourth-ranking, the Netherlands accounted for 11,025 tons and the outstanding products were plate, 7,981 tons; and tin plate, 1,369 tons. Chile followed with 9,465 tons of, principally, rails, 5,728 tons. Italy's purchases totaled 6,604 tons and were practically all confined to pig iron, 6,174 tons.

✦ ✦ ✦

IMPORTS of structural shapes in October amounted to 3,279 tons against 1,902 tons in the earlier month and 4,097 tons in October, 1937, and came from chiefly Belgium 2,541 tons; and France 689 tons. Steel pipe ranked next with 3,243 tons against 2,339 tons and 1,781 tons and was taken mostly from Germany, 1,933 tons; and Czechoslovakia, 622 tons. Then came hoops and bands with 2,946 tons against 1,790 tons and 1,310 tons, the principal suppliers being Belgium, 1,767 tons; and France, 1,093 tons. Spiegeleisen receipts totaled 2,720 tons against 1,069 tons and 222 tons and 2,719 tons came from Canada. Ferromanganese receipts amounted to 2,281 tons against 3,887 tons and 11,870 tons and were taken from chiefly Norway 1,297 tons; and Czechoslovakia, 672 tons. Steel bars ranked sixth in this trade with 1,347 tons against 1,230 tons and 1,942 tons.

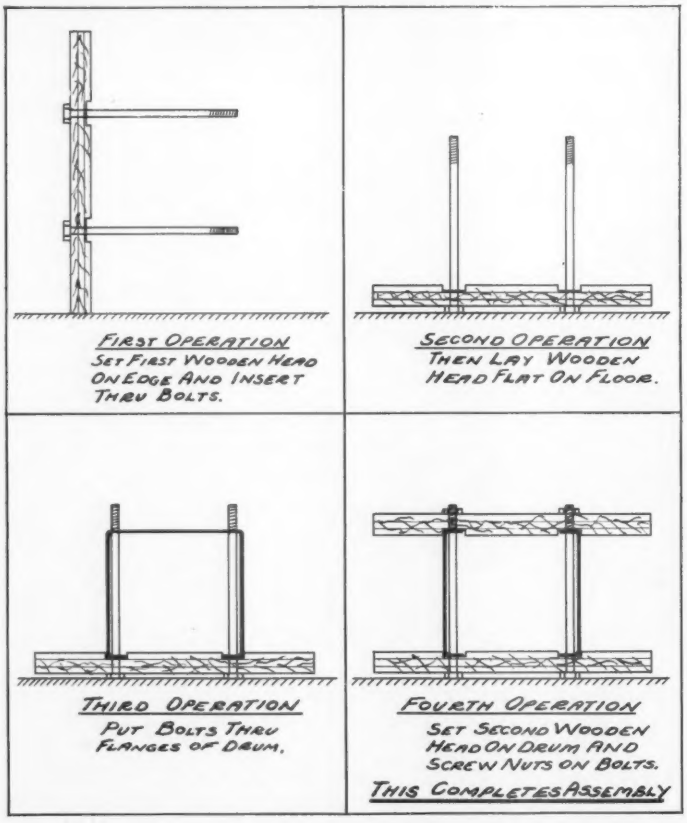
(*Please turn to Page 70*)

Exports and Imports

(*Continued from Page 69*)

AFTER lagging in September, Belgium in October regained its position as the leading supplier of iron and steel products (excluding scrap) to the United States, accounting for 5,730 tons made up of chiefly shapes, 2,541 tons; hoops and bands, 1,767 tons; and steel bars, 682 tons. Germany followed with 4,128 tons of mostly steel pipe, 1,933 tons; barbed wire, 740 tons; and sheet piling, 235 tons. Then came Canada with 3,369 tons consisting of chiefly spiegeleisen, 2,719 tons; and pig iron, 335 tons. France ranked next with 2,692 tons and the outstanding items were hoops and bands, 1,093 tons; shapes, 689 tons; and steel bars, 379 tons. Norway was fifth with 1,307 tons and here the outstanding item was ferromanganese, 1,297 tons.

FOUR OPERATIONS
TO ASSEMBLE REELS
EQUIPPED WITH
STEVENS FLANGED STEEL DRUMS


FIRST OPERATION
SET FIRST WOODEN HEAD ON EDGE AND INSERT THRU BOLTS.
SECOND OPERATION
THEN LAY WOODEN HEAD FLAT ON FLOOR.
THIRD OPERATION
PUT BOLTS THRU FLANGES OF DRUM.
FOURTH OPERATION
SET SECOND WOODEN HEAD ON DRUM AND SCREW NUTS ON BOLTS.
THIS COMPLETES ASSEMBLY

Made in Low Carbon Steel for Standard Weight and in High Carbon and Alloy Steels for Special Light Weight Drums.

Galvanized — Painted — Plain Finishes

THE STEVENS METAL PRODUCTS COMPANY
NILES, OHIO

EXPORTS of iron and steel wood screws during October, 1938 totaled 9,981 gross valued at $1,928. Of this total Cuba took 3,487 gross valued at $663; Canada 1,821 gross valued at $355; Mexico 968 gross valued at $173; Costa Rica 745 gross valued at $92; Netherlands 505 gross valued at $92; Dominican Republic 450 gross valued at $68; Surinam 300 gross valued at $31.

✦ ✦ ✦

EXPORTS of brass wood screws during the same month totaled 2,414 gross valued at $794. Of this total the United Kingdom took 1,132 gross valued at $210; Bermuda 272 gross valued at $134; Venezuela 198 gross valued at $172; Other British West Indies 186 gross valued at $79; Costa Rica 165 gross valued at $32.

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IMPORTS of wood screws during the same month totaled 13,398 gross valued at $1,074. Of this total Czechoslovakia supplied 10,910 gross valued at $796; Germany 1,035 gross valued at $96; Japan 1,000 gross valued at $81; United Kingdom 333 gross valued at $89; Canada 120 gross valued at $12.

✦ ✦ ✦

CARD CLOTHING receipts totaled 17,822 square feet valued at $29,069 as against 11,799 square feet valued at $18,497, and came from the United Kingdom (15,795 square feet valued at $25,037); Belgium (1,584 square feet valued at $3,163); and Germany (443 square feet valued at $869).

✦ ✦ ✦

RECEIPTS of WIRE HEDDLES totaled nothing this month.

✦ ✦ ✦

A TRADE of 49,760 square feet against 27,169 square feet resulted in WIRE CLOTH AND SCREEN and came from Germany, 15,864 square feet; the Netherlands, 15,864 square feet; and Canada, 9,237 square feet.

✦ ✦ ✦

FOURDRINIER AND OTHER PAPER-MAKING WIRE imports at 18,652 square feet as against 15,406 square feet, and were supplied principally from Germany (15,418 square feet), and France (1,546 square feet).

(*Please turn to Page 84*)

The Wire Association Registered Attendance At Annual Meeting, Detroit, Mich., October 17-21, 1938

AIKEN, J. C., Asst. Supt.,
Jones & Laughlin Steel Corp.,
Aliquippa, Pa.

ANDERSON, H. W., Pres. & Gen. Mgr.,
Fidelity Machine Co.,
Philadelphia, Pa.

ANJESKEY, A. F., Sales Mgr.,
Cleveland Tramrail Div. of
Cleveland Crane & Engineering Co.,
Wickcliffe, Ohio.

AVERY, J. M., Engineer,
A. D. Little, Inc.,
Cambridge, Mass.

BABB, C. W., Works Mgr.,
Columbus Bolt Works Co.,
Columbus, Ohio.

BACHMAN, G. A.,
National Standard Co.,
Niles, Michigan.

BALDRIDGE, W. M., Engineer of Tests,
Laclede Steel Co.,
Alton, Illinois.

BARKER, L. B., Testing Engineer,
General Electric Co.,
Schenectady, N. Y.

BARTHLEMESS, JOS. F., Production Mgr.,
National Lock Washer Co.,
Milwaukee, Wisc.

BASSETT, WILLIAM H., JR., Mgr.,
Metallurgical Development,
Anaconda Wire & Cable Co.,
Scarsdale, N. Y.

BEAMAN, P. A., Sales Manager,
Morgan Construction Co.,
Worcester, Mass.

BEARDSLEE, K. R., General Sales Mgr.,
Carboloy Company, Inc.,
Detroit, Michigan.

BEESON, J. K., Asst. Mgr. Sales,
Pittsburgh Steel Co.,
Pittsburgh, Pa.

BEIGHLEY, A. E.,
American Chemical Paint Co.,
Ambler, Pa.

BENNETT, H., Superintendent,
Graham Nail & Wire Products,
Toronto, Canada.

BILLERBECK, WM. J., Engineer,
American Insulating Machinery Co.,
Philadelphia, Pa.

BLOUNT, HARRY, Mfg. Engineer,
Western Electric Co.,
Baltimore, Md.

BLOXDORF, WALTER R., Metallurgist,
Macwhyte Company,
Kenosha, Wisc.

BOLL, JOHN K., Mgr. Wire Sales,
Wheeling Steel Corp.,
Wheeling, West Va.

BOSWIN, GEORGE A., Sales Manager,
Stevens Metal Products Co.,
Niles, Ohio.

BRALEY, S. A., Fellow,
Mellon Institute,
Pittsburgh, Pa.

BRANDON, F. C., Metallurgist,
Union Drawn Steel Div.,
Republic Steel Corp.,
Massillon, Ohio.

BROADDUS, E. T., Representative,
Firth-Sterling Steel Co.,
Chicago, Illinois.

BRODEN, G. A., President,
Broden Construction Co.,
Cleveland, Ohio.

BRONSON, W. D., Representative,
Carboloy Company,
Chicago, Illinois.

BROTEN, O. A., Vice-President,
National Pneumatic Co.,
New York, N. Y.

BROWN, FRANK K., Superintendent,
Continental Screw Co.,
New Bedford, Mass.

BROWN, HUGH E., Director of Research,
W. S. Tyler Co.,
Cleveland, Ohio.

BROWN, RICHARD E., President,
"Wire and Wire Products",
New York, N. Y.

BRUESTLE, CARL O., Designing Engineer,
Syncro Machine Co.,
Rahway, N. J.

(Please turn to Page 72)

Start Keystone wire going through your plant—and it will speak for itself in terms of smoother, faster production with fewer delays and rejections. The reason is, it's wire completely suited to your needs . . . in analysis, characteristics, finish. One of many regularly stocked grades may fill the bill—or it may be specially made for you alone. But if Keystone supplies your wire, you'll get performance and uniformity worth celebrating! Shall we show you what we mean?

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SPRING
WIRE
KEYSTONE STEEL & WIRE CO. PEORIA, ILL.

HIGH CARBON
or
LOW CARBON

Bright . . . Tinned
Coppered
Annealed
Galvanized

KEYSTONE

STEEL & WIRE CO., Dept. W, PEORIA, ILL.

WIRE

To consider your special needs and problems in wire, all the skill and experience of our metallurgists are at your command. Perhaps—as has happened with many manufacturers—they can point the way to faster work, fewer rejections, lower costs, and a better, more dependable product. As specialists in low-carbon wire we often can furnish a combination of analysis and temper that simplifies fabrication and improves strength in the final product.

Besides special-analysis and copper-bearing steel wire Continental — and only Continental—offers wire of Konik, the patented new steel containing copper, nickel, and chromium. Konik's amazing amenability to carburizing and heat-treatment permits new peaks of hardness, toughness, and resistance to abrasion. Its economies have been proved in four years of use by a variety of manufacturers.

Among the finishes offered by Continental are bright, bright and black annealed; sull-coated; processed; galvanized, including Flame-Sealed; liquored, coppered and tinned in many modifications. Eight shapes are standard, and many specials available. Regular gauges run from No. 34 to 5/8 inch. Furnished in coils of suitable sizes, or cut and straightened to specification.

CONTINENTAL STEEL CORPORATION

General Offices: Kokomo, Indiana • Plants at Canton, Kokomo, Indianapolis

CONTINENTAL

STEEL SHEETS AND WIRE PRODUCTS

Wire: Bright Basic, Annealed, *Konik, Special Manufacturers, Galvanized, *Flame-Sealed

Wire Rods, Nails, Staples, Bale Ties, Barbed Wire; Fence — 15 Types; Gates and Fittings

Sheets: Black, Galvanized, Special Coated; Roofing and Siding — 14 *Styles

*Trade Mark Registered, U. S. Patent Office

Wire Association Attendance List

(Continued from Page 71)

BUCHANAN, D. D., Asst. General Mgr.,
Union Drawn Steel Div.,
Republic Steel Corp.,
Massillon, Ohio.

BUCKLES, T. R., Foreman,
General Electric Co.,
Fort Wayne, Indiana.

BURGOON, BENNETT, JR.,
Mechanical Engineer,
American Locomotive Co.,
Railway Steel Spring Div.,
Latrobe, Pa.

CALLAGHAN, J. C., Works Manager,
Canada Wks., Steel Co. of Canada, Ltd.,
Hamilton, Ontario, Canada.

CARLSON, JULIUS, Foreman.
Canadian Steel Corp.,
Ojibway, Ont., Canada.

CASEY, AUSTIN, Sales Engineer,
Syncro Machine Co.,
New York, N. Y.

CHRISTIN, R. E., Metallurgist,
Columbus Bolt Works Co.,
Columbus, Ohio.

CHURCHILL, COL. J. M.,
2nd Infantry, U. S. Army,
Fort Wayne,
Detroit, Michigan.

CLARK, ARTHUR R., Salesman,
Canadian General Electric Co.,
Hamilton, Ontario, Canada.

CLARK, E. W., Mechanical Engr.,
General Electric Co.,
Schenectady, N. Y.

CLARK, HERBERT B., Vice-President,
Union Wire Die Corp.,
Stamford, Conn.

CLIFFORD, R. K., Works Manager,
Continental Steel Corp.,
Kokomo, Indiana.

COPPICK, J. C., Manager,
St. Lawrence Wire Div.
Dominion Steel & Coal Corp.,
Montreal, Quebec, Canada.

CORNELIUS, TAYLOR, Asst. Supt. Wire Mill,
Aluminum Co. of Canada, Ltd.,
Shawinigan Falls, P. Q., Canada.

COCHRAN, I. G., Supt. Wire Mill,
Laclede Steel Co.,
Alton, Illinois.

CRAMER, R. E., Dist. Engineer,
American Steel & Wire Co.,
Pittsburgh, Pa.

CRANE, CLYDE C., Metallurgist, Wire Div.,
Republic Steel Corp.,
Chicago, Illinois.

CRANE, MAJOR R. Z., Ordnance Dept.,
U. S. Army,
Detroit, Michigan.

CRAWFORD, W. H., Vice-President,
Eaton Mfg. Company,
Massillon, Ohio.

DAVIS, C. H., Metallurgist,
American Brass Co.,
Waterbury, Conn.

de FINES, WALTER,
Plant & Product Engineer,
Fort Pitt Bedding Co.,
Pittsburgh, Pa.

DEMPSEY, NELSON W., District Metallurgist,
American Steel & Wire Co.,
Worcester, Mass.

DENNISON, RALPH C., Engineer,
General Electric Co.,
Fort Wayne, Indiana.

DESCOMBES, L. E., Superintendent,
Wire & Spring Div.,
International Harvester Co.,
Springfield, Ohio.

DIMLING, PAUL E., Salesman,
Firth-Sterling Steel Co.,
McKeesport, Pa.

DIXON, EDWIN M., Advertising Manager,
"Wire & Wire Products",
New York, N. Y.

DONACHIE, MATTHEW J., Engineer,
Geo. W. Prentiss Co.,
Holyoke, Mass.

DOVE, A. B., Chemical Engineer,
Steel Co. of Canada, Ltd.,
Montreal, Quebec, Canada.

DOYLE, J. A., Vice-President,
W. S. Rockwell Co.,
New York, N. Y.

DUNHAM, L. H., Dist. Metallurgist,
American Steel & Wire Co.,
Chicago, Illinois.

DUNKELBERGER, L. E., Plant Manager,
Reynolds Wire Co.,
Dixon, Illinois.

EASTLAKE, WM. H., Works Mgr.,
Cable Div., Northern Electric Co., Ltd.,
Montreal, Quebec, Canada.

EDICK, H. L., Gen. Supt.,
Wickwire Brothers,
Cortland, N. Y.

ELDER, FLINT C.,
Chief Metalgst. & Dir. of Research,
American Steel & Wire Co.,
Cleveland, Ohio.

ELIAS, H. W., Asst. Mgr.,
Firthaloy Div.,
Firth-Sterling Steel Co.,
Flushing, L. I., N. Y.

ENSINGER, M. G., President,
Union Wire Rope Corp.,
Kansas City, Mo.

FAIRBROTHER, W. D., Factory Manager,
Wallace Barnes Co., Ltd.,
Hamilton, Ont., Canada.

FANTONE, C. B., President,
Syncro Machine Co.,
New York, N. Y.

FAST, PAUL R., Plant Supt.,
Belden Manufacturing Co.,
Chicago, Illinois.

FINDLEY, J. K., Metallurgist,
Allegheny Ludlum Steel Co.,
Dunkirk, N. Y.

FINK, DR. COLIN G., Head,
Div. of Electrochemistry,
Columbia University,
New York, N. Y.

FISHER, E. J. P., Asst. Mgr.,
Tube Mill & Cold Drawn Div.,
Aetna Standard Engineering Co.,
Youngstown, Ohio.

FOSBURG, HILDOR A., Secretary,
The Meaker Company,
Chicago, Illinois.

FRETER, ROY J., Chief Engineer,
Columbus Bolt Works,
Columbus, Ohio.

GADD, HARRY, Representative,
Carboloy Div.,
Canadian General Electric Co., Ltd.,
Toronto, Ont., Canada.

GALLOWAY, JAMES W., Plant Engineer,
B. Greening Wire Co., Ltd.,
Hamilton, Ont., Canada.

GINSBURGH, MAJOR A. R., Asst. Executive,
Office Asst. Sec'y. of War,
Washington, D. C.

GLADER, FRANK J., President,
Wm. Glader Machine Works,
Chicago, Illinois.

GLEN, A. E., Salesman,
Carboloy Company, Inc.,
Pittsburgh, Pa.

GRANGER, L. D., Treasurer,
American Wire Fabrics Corp.,
New York, N. Y.

GRASSELL, P. W., President,
Wilson Steel & Wire Co.,
Chicago, Illinois.

GREAVES, R. K., Vice-President,
Ekstrand & Tholand,
Detroit, Michigan.

GREEN, L. E., Sales Manager,
Trauwood Engineering Co.,
Cleveland, Ohio.

GREGG, WILLIAM K., Plant Engineer,
General Electric Co.,
Fort Wayne, Indiana.

GRIGGS, FRANK H., Vice-President,
Fansteel Metallurgical Corp.,
North Chicago, Ill.

GUNDSTROM, E. W., Asst. Plant Manager,
Rome Cable Corp.,
Rome, N. Y.

HAARBAUER, H. W., Supt. Wire Mill,
Townsend Company,
New Brighton, Pa.

HAGNER, RANDALL, Textile Engineer,
Owens Illinois Glass Co.,
Newark, Ohio.

HAKA, JOHN E., Works Manager,
Midland Wire Corp.,
Tiffin, Ohio.

HALL, EDW. P., Metallurgist,
Kennecott Wire & Cable Co.,
Phillipsdale, R. I.

HAMMERSLEY, ALBERT W., Superintendent,
Canadian Steel Corp., Ltd.,
Ojibway, Ont., Canada.

HAMMERSTEIN, H. K., Chief Engineer,
Broderick & Bascom Rope Co.,
St. Louis, Missouri.

HAMMITT, S. J., Manager,
Morrison Steel & Wire Co., Ltd.,
Vancouver, B. C., Canada.

HARRISON, C. E., Asst. Sales Manager,
The Steel Co., of Canada, Ltd.,
Hamilton, Ont., Canada.

HARTLEY, GEO. D., Consultant,
Worcester, Mass.

HAUGER, F. M., Plant Superintendent,
Wilson Steel & Wire Co.,
Chicago, Illinois.

HESSDOERFER, GEO. M., Sales Engineer,
Lewis Machine Company,
Cleveland, Ohio.

HILL, H. W., Supt. Wire Division,
Northwestern Steel & Wire Co.,
Sterling, Illinois.

HILL, WILLIAM E., Superintendent,
Russell, Burdsall & Ward,
Rock Falls, Ill.

HIRE, HARRY E., Supt. Wire & Insulation Div.
General Electric Co.,
Fort Wayne, Indiana.

HITCHCOCK, WM. E., JR.,
The Atlantic Wire Co.,
Branford, Conn.

HITCHCOCK, WM. E., SR., President,
The Atlantic Wire Co.,
Branford, Conn.

HODGE, W. W., Research Fellow,
American Iron & Steel Institute,
Mellon Inst. of Industrial Research,
Pittsburgh, Pa.

HOCHLE, DR. HEINZ, Metallurgist,
Hoesch, A. G.,
Dortmund, Germany.

HOLMES, ALVIN W., Engineer,
Indiana Steel & Wire Co.,
Muncie, Indiana.

HOOKER, HORACE W., JR.,
Development & Research,
Hooker Electrochemical Co.,
Niagara Falls, N. Y.

HOPKINS, H. L., Metallurgist,
National Screw & Mfg. Co.,
Cleveland, Ohio.

HORSFALL, DOUGLAS, Works Manager,
Canada Wire & Cable Co.,
Toronto, Ont., Canada.

HUBBARD, E. J., President,
Hubbard Spool Co.,
Chicago, Illinois.

HUBBARD, E. J., JR.,
Hubbard Spool Co.,
Chicago, Illinois.

(Please turn to Page 74)

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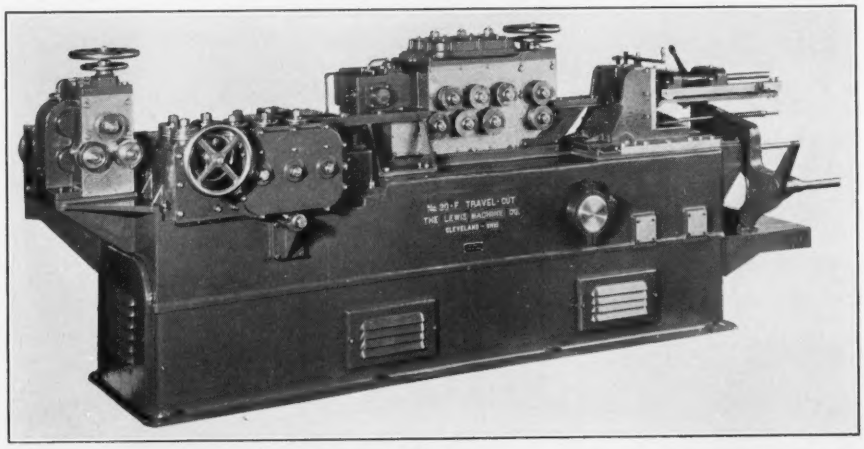

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Wire Association Attendance List

(Continued from Page 73)

HUGHES, CHARLES E., Representative,
Firth-Sterling Steel Co.,
McKeesport, Pa.

HUSSEY, R. M., Supt. Rod & Wire Dept.,
Jones & Laughlin Steel Corp.,
Aliquippa, Pa.

IHRIG, HOWARD K., Engineer,
Carnegie Illinois Steel Corp.,
Pittsburgh, Pa.

JACKMAN, ALAN, Representative,
Firth-Sterling Steel Co.,
Chicago, Illinois.

JACKSON, R. H., General Manager,
Canadian Elevator Equipment Co., Ltd.,
Toronto, Canada.

JENSEN, C. L., Sales Manager,
Ironsides Company,
Columbus, Ohio.

JOHNSON, C. E., Supt. Rod & Wire,
Bethlehem Steel Co.,
Sparrows Point, Md.

JONES, G. R., Wire Rope Engineer,
Canada Wire & Cable Co., Ltd.,
Toronto, Canada.

JOSEPHSON, HARRY C., Vice-Pres. & Sec'y.,
Smith & Davis Mfg. Co.,
St. Louis, Missouri.

KELLOGG, C. A., Chief Metallurgist,
Continental Steel Corp.,
Kokomo, Indiana.

KENYON, H. G., Supt. Wire Dept.,
General Electric Co.,
Pittsfield, Mass.

KITSELMAN, HARRY L., Secretary,
Indiana Steel & Wire Co.,
Muncie, Indiana.

KNOLL, W. F., Superintendent,
Dominion Steel & Coal Corp., Ltd.,
St. John, N. B., Canada.

KNOX, J. D., Associate Editor,
"Steel",
Cleveland, Ohio.

KREISBERG, SOL, Wire Investigator,
Jones & Laughlin Steel Corp.,
Aliquippa, Pa.

KRUEGER, E. W., Representative,
Keystone Steel & Wire Co.,
Chicago, Illinois.

KUHNLE, L. V.,
Asst. Mgr., Bar & Wire Sales,
Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

KLEIN, H. C., Sales Engineer,
B. F. Goodrich Co.,
Akron, Ohio.

LAMONT, WILLIAM D., Metallurgist,
Dominion Foundries & Steel Ltd.,
Hamilton, Ont., Canada.

LANDIS, MAURICE N., Chief Metallurgist,
LaSalle Steel Co.,
Hammond, Indiana.

LAWTON, M. P., Gen. Foreman,
Fence & Galvanizing,
Jones & Laughlin Steel Corp.,
Aliquippa, Pa.

LEWIS, KENNETH B.,
Consulting Engineer,
Worcester, Mass.

LONG, CARLETON C.,
Director, Plant Research Dept.,
St. Joseph Lead Co. of Pa.,
Monaca, Pa.

LONGLEY, T. E., Representative,
Master Wire Die Corp.,
Cleveland, Ohio.

LONGNECKER, HARRY, Representative,
Firth-Sterling Steel Co.,
McKeesport, Pa.

LONGWELL, JAMES R., Chief Engineer,
Carboloy Company, Inc.,
Detroit, Michigan.

LYNN, H. W., Sales Manager,
Wean Engineering Co., Inc.,
Warren, Ohio.

McAULIFFE, F. L., Cost Acct.,
General Electric Co.,
Schenectady, N. Y.

McCARTHY, B. L., Metallurgist,
Wickwire Spencer Steel Co.,
Buffalo, N. Y.

McDONALD, D. C.,
Supt. Nail & Wire Mill,
Dominion Steel & Coal Corp., Ltd.,
Sydney, N. S., Canada.

McGOWAN, C. L., Supt. Wire Mills,
Atlantic Steel Co.,
Atlanta, Ga.

McGREEVY, J. G., Vice-President,
Apco Mossberg Corp.,
Attleboro, Mass.

McILVRIED, E. J., Vice-President,
Vaughn Machinery Co.,
Cuyahoga Falls, Ohio.

McKAY, M. PARK, Asst. Plant Engineer,
B. Greening Wire Co. Ltd.,
Hamilton, Ont., Canada.

MAHER, J. J., Metallurgist,
Page Steel & Wire Co.,
Monessen, Pa.

MAHONEY, EDMOND, Supt. Wire Mill,
Canadian Tube & Steel Products,
Montreal, Quebec, Canada.

MANNING, WILLIAM H., Mgr.,
Insulation Division,
John A. Manning Paper Co.,
Troy, New York.

MANTIUS, DR. OTTO, Consulting Engineer,
National Lead Co.,
(Acid Recovery Dept.,)
New York, N. Y.

MARTIN, F. L., Dist. Sales Mgr.,
Warner Company,
Pittsburgh, Pa.

MELVILLE, NORMAN F.,
Mgr, Mfgrs. Wire Sales,
Pittsburgh Steel Co.,
Pittsburgh, Pa.

MEYER, F. W., Supt. Wire Mill,
The W. S. Tyler Co.,
Cleveland, Ohio.

MILLER, C. G., Treasurer,
The Meaker Company,
Chicago, Illinois.

MORDICA, JOHN W., Representative,
Firth-Sterling Steel Co.,
McKeesport, Pa.

MORGAN, PHILIP M., Treasurer,
Morgan Construction Co.,
Worcester, Mass.

MORITZ, JOHN A., Supt. of Wire Mills,
Keystone Steel & Wire Co.,
Peoria, Illinois.

MORRISON, J. R., President,
Morrison Engineering Co., Inc.,
Cleveland, Ohio.

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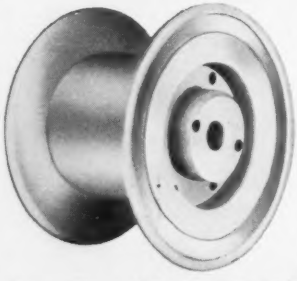

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MORROW, J. G., Metallurgical Engineer,
Steel Co. of Canada, Ltd.,
Hamilton, Ont., Canada.

MOSLO, ERNEST P., President,
Moslo Machinery Inc.,
Cleveland, Ohio.

MYERS, HAROLD A., Sales Manager,
Terkelsen Machine Co.,
Boston, Mass.

NEAL, CHARLES, Salesman,
Canadian General Electric Co., Ltd.,
Toronto, Canada.

NEUHAUS, RICHARD, President,
Nukem Products Corp.,
Buffalo, N. Y.

NORMILE, E. M., Salesman,
Keystone Steel & Wire Co.,
Peoria, Illinois.

NORTON, L. H., Asst. Supt.,
The National Screw & Mfg. Co.,
Cleveland, Ohio.

ORR, C. E., Elec. Engineer,
Syncro Machine Co.,
New York, N. Y.

PADOWICZ, H. N., Metallurgical Engineer,
Western Electric Co.,
Kearny, N. J.

PARKIN, WM., President,
The Wm. Parkin Co.,
Pittsburgh, Pa.

PASSOLT, H. H., Metallurgist,
Page Steel & Wire Div.,
Monessen, Pa.

PATTERSON, JOHN W., Metallurgist,
The Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

PIERCE, EDWIN H.,
Westerly, R. I.

PETERS, W. A., Metallurgist,
Laclede Steel Co.,
Alton, Illinois.

PETERSON, R. O., Development Engineer,
Osborn Manufacturing Co.,
Cleveland, Ohio.

PIERSON, W. D., Secretary,
Waterbury Farrel Foundry & Machine Co.,
Waterbury, Conn.

PIRK, G. W., Metallurgist,
General Cable Corp.,
Rome, N. Y.

RATZER, WM., Plant Engineer,
Belden Manufacturing Co.,
Chicago, Illinois.

REEDER, A. M., Metallurgical Engineer,
Jones & Laughlin Steel Corp.,
Pittsburgh, Pa.

RENNELL, HARRY H., General Manager,
The C. O. Jelliff Mfg. Corp.,
Southport, Conn.

RICHARDS, JOHN S.,
Mgr., Metallurgical Dept.,
American Steel & Wire Co.,
Cleveland, Ohio.

RICHARDS, WALTER A., Western Mgr.,
New England Butt Co.,
Chicago, Illinois.

ROLLE, SIDNEY, Asst. Manager,
U. S. Metals Refining Co.,
New York, N. Y.

ROTH, RALPH B., Purchasing Agent,
The Ludlow-Saylor Wire Co.,
St. Louis, Missouri.

SCHNEE, V. H., Fellow,
Battelle Memorial Institute,
Columbus, Ohio.

SCHUSLER, F. P., Mgr., Industrial Sales,
Keystone Steel & Wire Co.,
Peoria, Illinois.

SEBURN, WM. A., Supt. Wire Mills,
Pittsburgh Steel Co.,
Monessen, Pa.

SEYMOUR, L. D., Asst. Supt., Canada Works,
Steel Co. of Canada, Ltd.,
Hamilton, Ont., Canada.

SHERMAN, C. L., Metallurgist,
Phillips Electrical Works, Ltd.,
Brockville, Ont., Canada.

SHILLING, J. H., Supt. Wire Div.,
Youngstown Sheet & Tube Co.,
Youngstown, Ohio.

SHORT, CHARLES, Salesman,
Steel Co. of Canada, Ltd.,
Hamilton, Ont., Canada.

SIMMONS, R. S., Metallurgist,
Keystone Steel & Wire Co.,
Peoria, Illinois.

SMITH, H. H.,
Pittsburgh Dist. Metallurgist,
American Steel & Wire Co.,
Pittsburgh, Pa.

SMITH, J. D., Sales Dept.,
Oakite Products, Inc.,
New York, N. Y.

SOMMER, LESTER B., Asst. to the President,
Mid-States Steel & Wire Co.,
Crawfordsville, Ind.

SOMERVILLE, W. E., Engineer,
W. E. Somerville & Co.,
Coal City, Illinois.

SPANGLER, S. F., Chemical Engineer,
Chemical Construction Corp.,
New York, N. Y.

SPENGLE, R. S., Sec'y.-Treas.,
"Wire & Wire Products",
New York, N. Y.

SULLIVAN, FRANK W., Asst. Gen. Mgr.,
United Wire & Supply Corp.,
Providence, R. I.

SULLIVAN, J. J., Supt. Cold Drawn,
Atlas Steels Ltd.,
Welland, Ont., Canada.

TATE, JOHN A., Asst. Metallurgist,
Indiana Steel & Wire Co.,
Muncie, Indiana.

TATNALL, R. R., Metallurgical Engineer,
Wickwire Spencer Steel Co.,
Worcester, Mass.

THOMAS, EARLE H., Superintendent,
Geo. W. Prentiss Co.,
Holyoke, Mass.

TIMBERLAKE, J. E., Wire Dept.,
Jones & Laughlin Steel Corp.,
Pittsburgh, Pa.

TIMBERS, H. H., Contract Manager,
Western Electric Co.,
New York, N. Y.

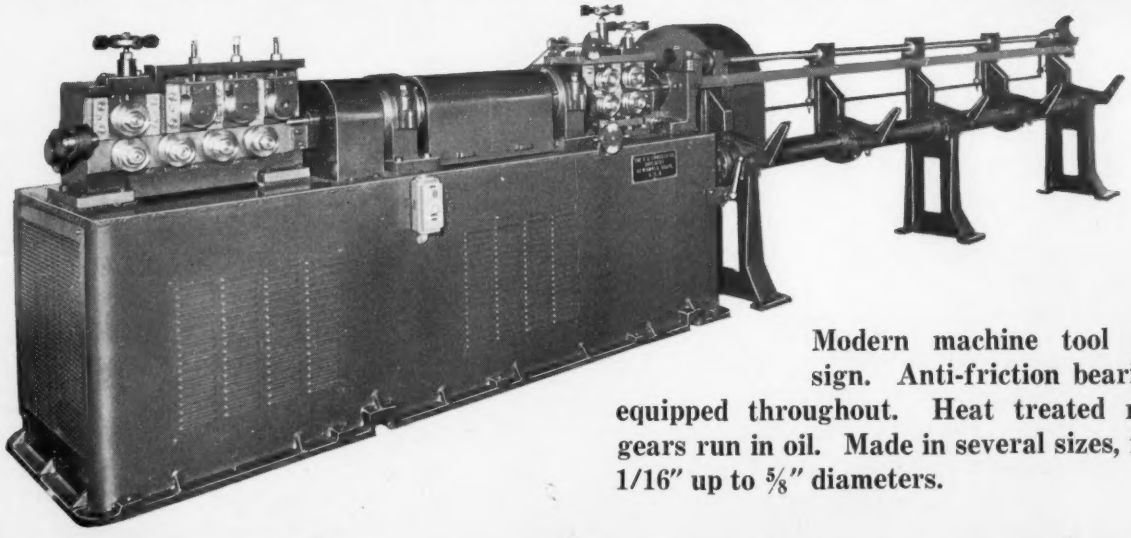
TROWNSELL, W. O., Metallurgist,
Continental Steel Corp.,
Kokomo, Indiana.

TWIBLE, W. J., Manager,
Graham Nail & Wire Products Ltd.,
Toronto, Ont., Canada.

VAUGHN, L. A., President,
The Vaughn Machinery Co.,
Cuyahoga Falls, Ohio.

(Please turn to Page 76)

Shuster Variable Speed AUTOMATIC
WIRE STRAIGHTENING AND CUTTING MACHINES



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Wire Association Attendance List

(Continued from Page 75)

VOIGTLANDER, CURTIS, Supt. of Wire Mill, Union Wire Rope Corp., Kansas City, Mo.
WARRICH, O. W., Gen. Supt., Pheoll Mfg. Company, Chicago, Illinois.
WARD, C. T., Asst. Supt. Rod & Wire Mills, Bethlehem Steel Co., Johnstown, Pa.
WEIKEL, G. A., Representative, American Chemical Paint Co., Ambler, Pa.
WESTPHAL, F. A., Supt. Wire Mills, Sheffield Steel Corp., Kansas City, Mo.
WEYANT, R. K., Chemist, Reynolds Wire Co., Dixon, Illinois.
WHEELER, A. P., Metallurgist, Wyman-Gordon Co., Harvey, Illinois.
WHITNEY, L. C., Chief Metallurgist, Copperweld Steel Co., Glassport, Pa.
WHYTE, R. B., General Supt., Macwhyte Company, Kenosha, Wisc.
WICKWIRE, CHESTER F., Treasurer, Wickwire Brothers, Cortland, N. Y.
WIGGINS, C. R., Metallurgist, Northwestern Steel & Wire Co., Sterling, Illinois.
WILKERSON, D. C., U. S. Naval Academy Alumni Assn., Detroit, Mich.
WILLIAMS, ROBERT C., Chief Chemist, Ironsides Company, Columbus, Ohio.
WIND, WILLIAM J., Secretary, Wilbur B. Driver Company, Newark, N. J.
WINKLER, L. H., Metallurgical Engineer, Bethlehem Steel Co., Bethlehem, Pa.
WOODARD, J. A., Works Manager, Federal Wire & Cable Co., Guelph, Ont., Canada.
WOODHEAD, R. R., Research Engineer, John A. Manning Paper Co., Inc., Troy, N. Y.
YORT, A. O., Supt. Wire Mill., Republic Steel Corp., Chicago, Illinois.
ZAPP, A. R., Manager, Firthaloy Div., Firth-Sterling Steel Co., McKeesport, Pa.
ZOUCK, JOHN, Chief Inspector, Rod & Wire Mills, Bethlehem Steel Co., Sparrows Point, Md.

✦ ✦ ✦

Wire Association Elects New Directors

AS a result of a mail ballot just completed, The Wire Association has elected the following Directors for a three-year term, commencing March, 1939, and ending March, 1942:

D. D. Buchanan, Assistant General Manager, Union Drawn Steel Div., Republic Steel Corp., Massillon, Ohio.

R. K. Clifford, General Works Mgr., Continental Steel Corporation, Kokomo, Indiana.

C. E. Johnson, Superintendent, Rod & Wire Mills, Bethlehem Steel Co., Sparrows Point, Md.

John A. Moritz, Superintendent, Wire Mills, Keystone Steel & Wire Co., Peoria, Illinois.

Sidney Rolle, Assistant Manager, Scomet Engineering Company, New York, N. Y. (formerly U. S. Metals Refining Company).

✦ ✦ ✦

IT is with real regret that announcement is made of the retirement of the following Directors, in accordance with the policy of the Association, established some years ago, that each year Directors who had served a full three-year term, should be replaced by other members of the Association, in order to keep a constant flow of new ideas injected in the handling of the affairs of the organization. The Association extends a vote of thanks and appreciation to these retiring Directors, who are:

H. B. Carnahan, Assistant Works Mgr., Canada Wire and Cable Company, Toronto, Ontario, Canada.

Kenneth B. Lewis, Consulting Engineer, 43 Midland Street, Worcester, Mass.

W. D. Pierson, Secretary, Waterbury Farrel Fdry. & Machine Co., Waterbury, Conn.

R. S. Simmons, General Metallurgist, Keystone Steel & Wire Co., Peoria, Ill.

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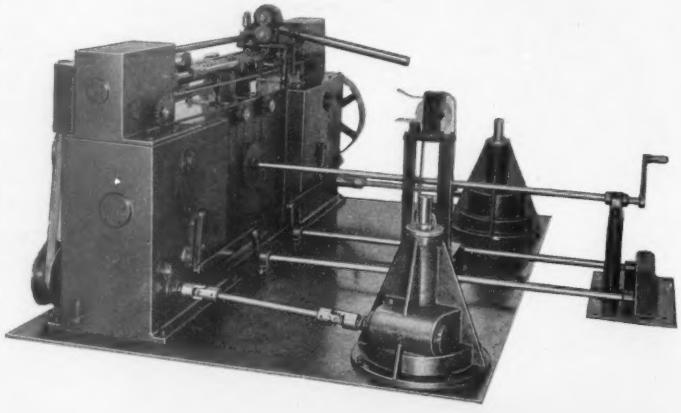
of rubber tuber machines is eliminated by . . .

Syncro Continuous *Double Pan* Take-Up Units . . .

The Syncro continuous double pan take-up unit increases production by eliminating costly stops of the rubber tuber machine each time a pan is filled.

This take-up unit is designed for use with two pans. When one pan is full, the operator actuates a trip clutch which severs the wire and directs it into the empty pan.

For complete details, write for bulletin No. 610.



SYNCRO

SYNCRO . MACHINE . COMPANY

420 Lexington Avenue New York

A Review of Recent Wire Patents

No. 2,135,333, WOVEN WIRE FABRIC, Patented November 1, 1938 by Raymond J. Guba, Philadelphia, Pa., assignor to Audubon Wire Cloth Corporation, a corporation of N. J.

In this woven wire belt, a continuous hinge rod extends entirely through each wire coil between the coil's turns and the overlapping turns of each adjacent coil, the ends of adjacent rods being rigidly connected.

✦ ✦ ✦

No. 2,135,607, BEDSPRING, Patented November 8, 1938 by Don Carlos Travis, Kenosha, Wis., assignor to Simmons Company, New York, N. Y., a corporation of Delaware.

In order to provide a large supporting area for mattresses, the inventor disposes a number of crossing straps, of thin flexible metal, as a diamond-shaped formation upon the upper side of the springs.

✦ ✦ ✦

No. 2,135,659, WIRE DRAWING APPARATUS, Patented November 8, 1938 by Nils Elfstrom, Fagersta, Sweden, assignor to National Standard Company, Niles, Mich., a corporation of Michigan.

A non-uniform or jerky movement is given the wire as it passes to the die through a powdered lubricant, thus agitating the lubricant and preventing it caking.

✦ ✦ ✦

No. 2,135,729, WIRE COILING MACHINE, Patented November 8, 1938 by Albert M. Olgay, Elmwood Park, Ill., assignor to The Lakeside Central Company, Chicago, Ill., a corporation of Illinois.

This is an automatically operated coiling and severing machine, with coil-discharging means.

✦ ✦ ✦

No. 2,135,800, FLEXIBLE WIRE, Patented November 8, 1938 by Victor D. Davignon, North Attleboro, Mass., assignor, by mesne assignments, to Metals & Controls Corporation, Attleboro, Mass., a corporation of Mass.

More particularly, this wire is adapted for use in the temple bow portions of the temple pieces of eyeglasses and comprises a non-corrodible wire coiled about a second wire coil which is disposed about a core.

✦ ✦ ✦

No. 2,135,886, TIRE WIRE AND METHOD OF MAKING THE SAME, Patented November 8, 1938 by Flint C. Elder, Cleveland Heights, Ohio, assignor to The American Steel and Wire Company of New Jersey, a corporation of New Jersey.

According to this invention, the rubber-adhering and corrosion-resisting properties of this wire are improved by his method, which employs a copper-tin alloy, of not more than 20% copper coating on the wire.

✦ ✦ ✦

No. 2,135,913, REELING DEVICE, Patented November 8, 1938 by Harley C. Ralston, Cleveland, Thomas D. Williams, Garfield Heights, and Frank Mako, Cleveland, Ohio, assignors to The American Steel and Wire Company of New Jersey, a corporation of N. J.

Complete Descriptions and Drawings of Patents May Be Had for 25 cents. Address, Wire & Wire Products, 17 East 42nd St., New York.

The device is adapted for association with hot rod mills and the like and the terminal convolutions of the rod or wire are constrained to conform in size and shape to the convolutions comprising the body of the coil.

✦ ✦ ✦

No. 2,135,937, COUPLING FOR WIRES OR ELECTRICAL CONDUCTORS, Patented November 8, 1938 by George B. Gordon, New York, N. Y.

A somewhat figure 8 shape is given this coupling which is said to resist vibrations and strains incidental to service.

✦ ✦ ✦

No. 2,136,714, MECHANISM FOR STRAIGHTENING WIRE, Patented November 15, 1938 by Abraham Simons, New York, N. Y., assignor to Washburn Wire Company, Inc., New York, N. Y., a corporation of New York.

Grooved rollers are provided, in staggered relation, the grooves being arranged in corresponding series and the wire run passing partially around the peripheries of one of the series of grooves.

No. 2,136,732, BALING WIRE, Patented November 15, 1938, by Raymond D. Buckwalter, Lancaster, Pa.

An eye of springy wire is provided at one end of the baling wire with a securing means, at the other end, engaging the wire of the eye.

✦ ✦ ✦

No. 2,136,865, WIRE ROPE, Patented November 15, 1938 by Malcolm W. Reed, Shaker Heights, Ohio.

Hoisting wire rope is provided comprising a number of separate wire ropes helically wound about a main core, with the main core having a greater resiliency than the individual wire ropes.

✦ ✦ ✦

No. 2,136,866, WIRE ROPE, Patented November 15, 1938 by Malcolm W. Reed, Shaker Heights, Ohio.

Spacing members for a number of wire ropes, making up a hoisting rope, are provided, these spacing members being made up of recessed, interfitting sections.

✦ ✦ ✦

No. 2,136,867, WIRE ROPE OR CABLE, Patented November 15, 1938 by Malcolm W. Reed, Shaker Heights, Ohio.

In this wire hoisting rope, the spacing member is integral.

(Please turn to Page 78)

OFHC

OXYGEN FREE HIGH CONDUCTIVITY

A Superior Copper

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OFHC Copper conforms to the A.S.T.M. Specification for electrolytic copper wirebars, cakes, etc., B5-27 with regard to metal content and resistivity, and is free from cuprous oxide.

OFHC Copper is characterized by its freedom from casting defects and its bar-for-bar uniformity. Its freedom from oxygen results in great ductility and toughness as evidenced by its high reduction of area and resistance to impact.

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G-75

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Why the Maintenance Man likes Duriron Equipment:

Because it makes his job easier

Most Maintenance Men are up to their necks in work. When the plant isn't rushed, the Maintenance Man is, trying to get replacements and repairs made. When the plant is busy, so is he, trying to keep everything running smoothly.

When he has Duriron equipment—**PUMPS, VALVES, PIPE AND FITTINGS, CIRCULATING AND HEATING JETS**—on his corrosive liquor lines, he checks off that department as one that he doesn't have to worry about. Because he knows from experience that Duriron equipment will keep right on working with a minimum of attention.

Every Maintenance Man should use Duriron equipment for corrosive solutions. It saves time for other jobs—and it's a money-saving move for his company.

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THE DURIRON COMPANY, Inc.

445 North Findlay St. Dayton, Ohio

A Review of Recent Wire Patents

(Continued from Page 77)

No. 2,137,257, METHOD OF MAKING WIRE MESH, Patented November 22, 1938 by Herbert E. White, San Francisco, Calif., assignor to E. H. Edwards Company, a corporation of California.

The method comprises laying wire strands in the form of coils upon a tubular mandrel, so constructed that, as the coils are carried away from the strand-laying mechanism, they assume spirals and the body is then flattened. Spaced portions of the walls of the body are brought together to form superposed layers of strands, crossing each other.

✦ ✦ ✦

No. 2,137,298, PROPORTIONAL RESISTANCE SPRING STRUCTURE, Patented November 22, 1938 by Charles F. McCoy, Pennington, N. J., assignor to Trenton Spring Products Company, Trenton, N. J., a corporation.

A spring mattress is provided in which the number of interlocks between adjacent coils is increased over conventional construction, whereby lateral sway is reduced.

✦ ✦ ✦

No. 2,137,325, WIRE TYING TOOL, Patented November 22, 1938 by Fred I. Anderson, San Antonio, Tex., assignor to American Telephone and Telegraph Company, a corporation of New York.

More specifically, this tool is adapted for securing line wires to insulators.

✦ ✦ ✦

No. 2,137,712, METHOD OF PROVIDING STRANDED STRUCTURES WITH FITTINGS, Patented November 22, 1938 by Otto J. Bratz, Adrian, Mich., assignor, by mesne assignments, to American Chain & Cable Company, Inc., a corporation of New York.

The method comprises wrapping the wire coil with a metal ribbon at separate predetermined points on the coil, severing the coil at such points by cutting through the ribbon and the coil so as to form a number of tubular casings each having a metal ribbon binding at each end thereof, and swedging the ribbon upon the coil at each end of the casing.

✦ ✦ ✦

No. 2,137,789, WIRE FABRIC SEAM AND METHOD OF MAKING SAME, Patented November 22, 1938 by William J. Taylor, Nutley, N. J.

A seam is provided which is not materially different from the remainder of the fabric, the latter being adapted for employment in endless webs in papermaking machines.

✦ ✦ ✦

No. 2,138,026, WIRE BENDING AND SECURING DEVICE, Patented November 29, 1938 by James B. Dempsey, Topeka, Kans., assignor to the Government of the United States, as represented by the Secretary of Commerce.

The device is one provided for bending wire ends together for securing the same to terminals.

✦ ✦ ✦

No. 2,138,126, METHOD OF AND APPARATUS FOR DRAWING WIRE, Patented November 29, 1938 by Frank H. Smith, New York, N. Y., and Henry

A. Stringfellow, St. Thomas, Ontario, Canada.

An object of the invention is to provide a mechanism for simultaneously applying forward and retarding pulls in such a manner that the applied forces are, to a great extent, balanced one against the other. It is said a substantial saving in horsepower is effected.

✦ ✦ ✦

No. 2,138,201, WIRE DRAWING METHOD AND APPARATUS, Patented November 29, 1938 by William A. Whittaker, Dobbs Ferry, N. Y., assignor to Ananconda Wire & Cable Company, New York, N. Y., a corporation of Delaware.

In order to reduce inequalities in strength of wire, the inventor bends the wire in several planes during the drawing process.

✦ ✦ ✦

No. 2,138,327, WIRE DRAWING MACHINE, Patented November 29, 1938 by Samuel Hugh Richards, Harpenden, England.

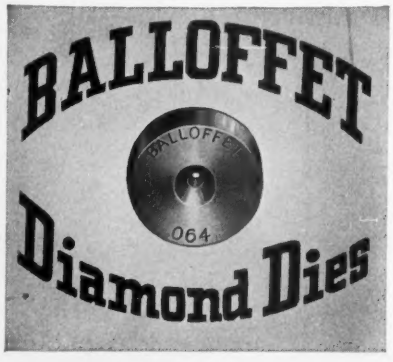
The invention lies in the provision of new means for securing the end of the wire to the block upon which the wire is wound for drawing through the die.

✦ ✦ ✦

No. 2,138,420, ELECTRICAL OVERHEAD CABLE, Patented November 29, 1938 by Henrich Glasser, Munich, and Josef Grobl, Solln, near Munich, Germany, assignors to Bayernwerk A.-G., Munich, Germany.

A cable is provided so that, it is said, cable oscillations of any frequency will be dampened to a minimum and the oscillatory energy of the field under tension at various points, will be destroyed.

✦ ✦ ✦



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The Metallurgy of Steel Wire

(*Continued from Page 25*)

the excess constituent is further retarded and it is found in finer particles mixed with the pearlite. The fact that the temperature of the lead bath is above that at which Martensite can develop, insures freedom of the steel from this constituent which can be very harmful in wire drawing. It is this feature, namely the fact that a decided lowering of the Ar_1 can be effected without the formation of Martensite which makes lead patenting desirable for wire such as music wire where a high tensile strength product is desired. By a combination of furnace and lead bath temperatures the tensile strength of the steel can be raised as much as 30,000 lbs. per sq. inch above that obtainable by air patenting and have a rod or wire which lends itself readily to cold work. In figure 42 is shown a typical lead patented structure.

✦ ✦ ✦

WHEN coarse sizes of wire are being produced it is often advisable to employ the lead patenting process. Because of the large diameter of the rod or wire from which the wire is drawn and the slow rate of cooling resulting from mass influence, the rate of cooling associated with the Air Patenting treatment is not fast enough to produce the desired microstructure and physical properties in the patented material.

✦ ✦ ✦

LEAD **patenting** is employed almost exclusively on steel containing over .80 carbon. In this case we have a hyper-eutectoid steel and the excess constituent is free cementite. It is important that the free cementite be in the smallest particle size, otherwise, because of its extreme hardness, it will impair the quality of the wire.

✦ ✦ ✦

Tempering

HIGH **Carbon Steel** wire can be divided into two classes. **Cold drawn** wire wherein the cold working strains are still present and on which we depend for physical properties, and **tempered** wire wherein the physical properties

(*Please turn to Page 80*)

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The Metallurgy of Steel Wire

(*Continued from page 79*)

are the direct result of heat treatment with no cold work being applied after heat treatment.

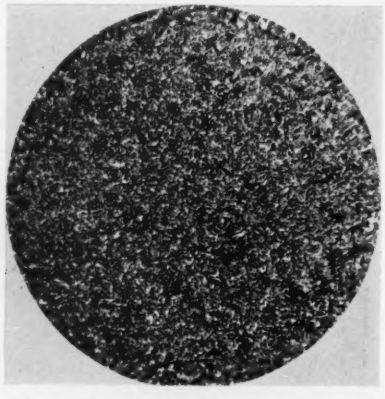
✦ ✦ ✦

IN the first case the wire is patented and we have as a product of the transformation, pearlite. In the second case the heat treatment is in the nature of a quench from relatively high temperatures causing the Austenite→Martensite transformation to occur. This in turn is reheated to precipitate Iron-Carbide along the lines previously discussed for the transformation of martensite.

✦ ✦ ✦

IN tempering, the wire is handled in strands from a reel or swift to the take-up block. This is imperative, because in coil form it would be impossible to obtain a uniform quench. The wire is first heated to approximately 1550°F by passing it through a furnace or lead-pan and then immediately quenched in oil. The quenched wire is next directed through a lead bath heated to between 800 and 1100°F depending on the desired hardness or temper; from the lead bath it may be cooled in water and then directed on to the take-up.

✦ ✦ ✦



Typical Oil Tempered Structure. Magnification 200X. ✦ ✦ ✦ ✦

FIGURE 43

BECAUSE of the need of some speed to carry the wire from the heating chamber into the oil, to obtain the desired quench effect, insufficient time is allowed for the metals to reach a stage of equilibrium with the temperature

of the heating bath, or chamber, or the tempering bath. Because of this, the temperature of these baths are higher than the temperature effect on the metal, that is, the heating bath may be held at 1550°F but it does not follow that the steel has the full temperature influence of 1550°F because time for equilibrium is not allowed. In the same manner the temperature of the lead tempering bath may be 1000°F yet the influence on the wire may be equivalent to a long exposure at 700°F.

✦ ✦ ✦

IN table V is shown some hardness results obtained by varying the length of time in a tempering bath maintained at 900°F.

TABLE V

.63 Carbon—.142 wire quenched from 1550°F and held at 900 F for varying lengths of time

	Hardness—Rockwell C
5 Seconds	56
½ Minute	48
1 "	42
2 "	40
5 "	39
10 "	39

WHILE this lack of time-at-temperature is not the most desirable from a metallurgical standpoint, the fact that time for grain growth in the austenite is lacking in the heating bath tends toward a finer austenitic grain size. This is desirable from a fatigue standpoint.

✦ ✦ ✦

FIGURE 43 was taken on a tempered wire, note the spheroidal condition of the Iron-Carbide, also the absence of cold working strains.

✦ ✦ ✦

Acknowledgement

In concluding this series of lectures on THE METALLURGY OF THE MANUFACTURE OF STEEL WIRE, the author wishes to express his appreciation and gratitude to the management of the WICKWIRE-SPENCER STEEL COMPANY in general and to MR. P. M. MACKLIN, Executive Vice-President in charge of operation and MR. F. JOHNSON, Superintendent of the Buffalo Works in particular, for permission to use the facilities of the Company in preparing these and other technical

(*Please turn to Page 82*)

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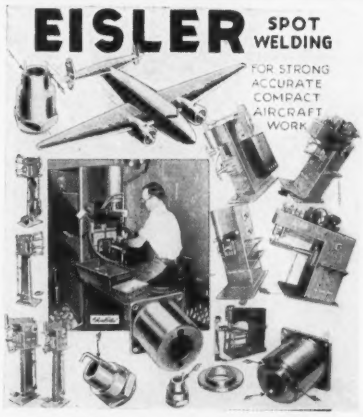

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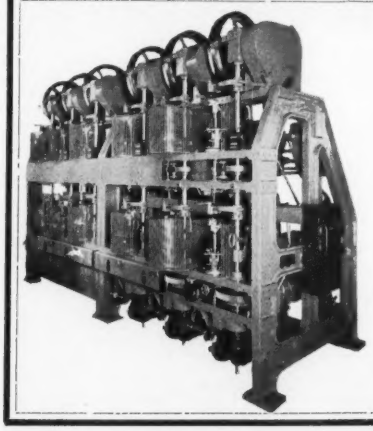

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The Metallurgy of Steel Wire

(*Continued from Page 81*)

articles which have been published. It is to men of their vision to whom credit for this work rightfully belongs, because they provide the equipment and opportunity for these studies and combine it with a friendly feeling of helpfulness which encourages a wholesome exchange of scientific information so essential to industrial development.

✦ ✦ ✦

Safe Handling

THE Macwhyte Company, of Kenosha, Wisconsin, recently issued a booklet, entitled "Safe Handling," which contains a very comprehensive description of the use of wire rope for heavy handling work.

✦ ✦ ✦

THIS booklet is very well illustrated, and copies may be obtained by addressing the Editor of "Wire and Wire Products."

✦ ✦ ✦

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✦ ✦ ✦

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THE new Irvin Works of Carnegie-Illinois Steel Corporation, major project in the modernization program of United States Steel Corporation, is to be formally opened December 15. Dedication of the plant, known locally as "the mill on the hill", will include an inspection trip by several hundred industrial leaders and Corporation officials. It is named for William A. Irvin, Vice Chairman of United States Steel.

✦ ✦ ✦

THE chief units of the plant are an 80-inch hot strip mill, an 84-inch tandem cold reducing sheet mill, and a 42-inch tandem cold reducing tin mill. These are supplemented by the necessary annealing furnaces, pickling and tinning departments. The mills are electrically operated and have an annual capacity of 600,000 tons.

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✦ ✦ ✦

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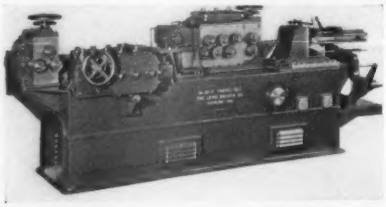
✦ ✦ ✦



THE rod is taken from the coil, run through the three-roll preliminary flat straightener which removes the coil bow, passes through the two horizontal feed rolls and six edge straightener rolls which straightens the rod edge ways, through the six flat straightener rolls where the flat straightening is completed, and comes out the two vertical feed rolls perfectly straight. It is then guided through the cut-off head and on into the guide bar where it trips the clutch by striking the gauge wire which has been set for a pre-determined length. After tripping the clutch, the rod moves forward to the positive length gauge traveling with the cut-off head where it is accurately gauged to length before being cut. The cut-off head, traveling with the rod, cuts while in motion and produces rods free of roll marks.

✦ ✦ ✦

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(5) **Forced feed lubrication to cut-off headways.**
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✦ ✦ ✦

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Exports and Imports

(*Continued from page 70*)

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ABRASIVES—
Norton Co., Worcester, Mass.

ANNEALING POTS AND BOXES—
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.

ANODES—
Seymour Mfg. Co., Seymour, Conn.

ANTI-RUST—
Magnus Chemical Co., Garwood, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

BAKERS—Rod and Wire
The American Machine & Foundry Co., Crawford Oven Div., New Haven, Conn.
Morgan Construction Co., Worcester, Mass.
Morrison Engineering Co., Cleveland, O.

BOBBINS—Braider and Wire Weaving
Apco Mossberg Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

BORON CARBIDE—
Norton Co., Worcester, Mass.

CARRIERS—Braider, High Speed
Apco Mossberg Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

CEMENT FLOOR CLEANER—
Magnus Chemical Co., Garwood, N. J.

CEMENTS—Refractory
Norton Co., Worcester, Mass.

CHEMICALS—Cleaning
American Chemical Paint Co., Ambler, Pa.
Magnus Chemical Co., Garwood, N. J.

CLEANERS—Hand and Metal
Magnus Chemical Co., Garwood, N. J.

CLEANING & PICKLING EQUIPMENT—
Broden Construction Co., Cleveland, O.
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.
Morgan Construction Co., Worcester, Mass.
Nukem Products Corp., Buffalo, N. Y.
Vaughn Machinery Co., Cuyahoga Falls, O.

COATING—Protective
American Lanolin Corp., Lawrence, Mass.

COILERS—Sheet, Strip and Wire
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

COLD HEADERS—
National Machinery Co., Tiffin, O.

CONDUITS—Iron and Steel
Youngstown Sheet & Tube Co., Youngstown, Ohio.

CONTROLS—Automatic
Leeds & Northrup Co., Philadelphia, Pa.

COPHOLDERS—Steel
Apco Mossberg Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

CRANES—Wire Mill
Cleveland Tramrail div. of Cleveland Crane and Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

DIAMOND TOOLS—
Rusch Wire Die Corp., New York, N. Y.

DIES—Diamond
Balloffet Die & Nozzle Co., Inc., Guttenberg, N. J.
Cochaud Wire Die Co., New York, N. Y.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Lead Extrusion
John Robertson Co., Brooklyn, N. Y.

DIES—Repairs & Re-Cutting
Balloffet Die & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Cochaud Wire Die Co., New York, N. Y.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willeys Carbide Tool Co., Detroit, Mich.

DIES—Rod and Tube Drawing
Balloffet Die & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willeys Carbide Tool Co., Detroit, Mich.

DIES—Tantalum Carbide
Balloffet Die & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.

DIES—Tungsten Carbide
Balloffet Die & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., New York, N. Y.
Vianney Wire Die Works, New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O

DRUMS—Flange Steel
Stevens Metal Products Co., Niles, O.

DRUMS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

ENGINEERS—Consulting Wire Mill
Hartley, George D., Worcester, Mass.
Lewis, Kenneth B., New York, N. Y.

EQUIPMENT—Insulation Testing
Leeds & Northrup Co., Philadelphia, Pa.

EYELETS—Brass or Zinc
Platt Bros. & Co., The, Waterbury, Conn.

FILLERS—Paper for Cable
E. W. Twitchell, Inc., Phila., Pa.

FLASH BAKERS—
Morrison Engineering Co., Cleveland, O.

FURNACE CONTROLS — Combustion and Draft
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Annealing
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Automatic
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Bright Annealing
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Lee Wilson Engineering Co., Cleveland, O.

FURNACES—Electric
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.

FURNACES—Galvanizing
Lee Wilson Engineering Co., Cleveland, O.

FURNACES—Hardening and Tempering
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Lead Melting
Electric Furnace Co., Salem, O.
John Robertson Co., Brooklyn, N. Y.

FURNACES—Non-Oxidizing
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.

FURNACES—Normalizing
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Leeds & Northrup Co., Philadelphia, Pa.

FURNACES—Salt Bath
Ajax Electric Co., Philadelphia, Pa.

FURNACES—Wire, Strip & Sheet
Ajax Electric Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.

GALVANIZING EQUIPMENT—
Lee Wilson Engineering Co., Cleveland, O.

GEARS—Wire Mill
Farrel-Birmingham Co., Ansonia, Conn.

GRINDERS—ROLL
Farrel-Birmingham Co., Ansonia, Conn.
Norton Co., Worcester, Mass.

HOISTS—Electric Travelling
Cleveland Tramrail div. of Cleveland Crane and Engineering Co., Wickliffe, O.

INHIBITORS—
American Chemical Paint Co., Ambler, Pa.

INSTRUMENTS—Electrical
Leeds & Northrup Co., Philadelphia, Pa.

INSULATION — Cable or Cable Filler
E. W. Twitchell, Inc., Phila., Pa.

LATHES—Die Reaming
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

LUBRICANTS—For Metal Cutting, Stamping and Drawing
Ironsides Co., The Columbus, Ohio.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.

LUBRICANTS—Wire Drawing
Ironsides Co., The Columbus, Ohio.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
John Robertson Co., Brooklyn, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Braiding
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Brazing
Hayes, C. I., Inc., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Bunching
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cable, Electric
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Vaughn Machinery Co., Cuyahoga Falls, O.

WHERE TO BUY, Continued

MACHINERY—Closing
New England Butt Co., Providence, R. I.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coil Winding
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Coilers
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
New England Butt Co., Providence, R. I.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cold Heading
National Machinery Co., Tiffin, O.

MACHINERY—Copper Wire Drawing and Rolling
Farrel-Birmingham Co., Ansonia, Conn.
H. J. Ruesch Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Covering Wire
Sinfra Corp., Jersey City, N. J.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Cutting
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
F. B. Shuster Co., New Haven, Conn.
W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Enameling
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Extruding
John Robertson Co., Brooklyn, N. Y.
Royle, John & Sons, Paterson, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Flat Wire
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Forming
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Galvanizing
Lee Wilson Engineering Co., Cleveland, O.

MACHINERY—Galvanizing Wire
Broden Construction Co., Cleveland, O.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Gang Winders
Fidelity Machine Co., Philadelphia, Pa.
H. J. Ruesch Machine Co., Newark, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grindi..
Norton Co., Worcester, Mass.

MACHINERY—Insulating
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Sinfra Corporation, Jersey City, N. J.
Syncro Machine Co., Rahway, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Knitting
Sinfra Corporation, Jersey City, N. J.

MACHINERY—Lead Encasing Presses, etc.
John Robertson Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
John Robertson Co., Brooklyn, N. Y.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Magnet Wire
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Material Handling
Cleveland Tramrail div. of Cleveland Crane and Engineering Co., Wickliffe, O.

MACHINERY — Measuring Wire & Cable
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works Co., Chicago, Ill.
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Panning
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Pointing
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Rod Mill
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.

MACHINERY—Rolling Mill
Broden Construction Co., Cleveland, O.
Farrel-Birmingham Co., Ansonia, Conn.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
H. J. Ruesch Machine Co., Newark, N. J.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Rubber for Insulating Wire
National Rubber Machinery Co., Akron, O.

MACHINERY—Rubber Strip Covering
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Mach'y. Co., Akron, O.
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Rubber Tubing and Straining
Farrel-Birmingham Co., Ansonia, Conn.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
Royle, John, & Sons., Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Screw Wire
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Worcester, Mass.

MACHINERY—Special
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
National Rubber Machinery Co., Akron, O.
New England Butt Co., Providence, R. I.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY— Special — Combination Machine for Drawing, Cutting-to-length. Straightening and Reeling Bars from Coil in One Operation (Shumag Type)—
W. A. Schuyler, New York, N. Y.

MACHINERY—Spooling
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Watson Machine Co., Paterson, N. J.

MACHINERY—Spring Making
National Machinery Exchange (Used), New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Staple
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Straightening
Broden Construction Co., Cleveland, O.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, O.
National Machinery Exchange (Used), New York, N. Y.
H. J. Ruesch Machine Co., Newark, N. J.
W. A. Schuyler, New York, N. Y.
F. B. Shuster, New Haven, Conn.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Stranding
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Steel
Broden Construction Co., Cleveland, O.
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Swaging
National Machinery Exchange (Used), New York, N. Y.
H. J. Ruesch Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Taping
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Testing Size of Wire
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Tinsel Rolling Mills
American Insulating Mach'y. Co., Phila., Pa.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Trolley Wire
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Tube Mill
H. J. Ruesch Machine Co., Newark, N. J.
Torrington Mfg. Co., The, Torrington, Conn.

MACHINERY—Welding Wire
Eisler Engineering Co., Inc., Newark, N. J.
F. B. Shuster Co., New Haven, Conn.
Thomson-Judd Wire Machinery Co., Lynn, Mass.

MACHINERY—Winding
American Insulating Mach'y. Co., Phila., Pa.
Fidelity Machine Co., Philadelphia, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Torrington Mfg. Co., The, Torrington, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Drawing
Aetna-Standard Engineering Co., Youngstown, O.
American Insulating Mach'y. Co., Phila., Pa.
Broden Construction Co., Cleveland, O.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (Used), New York, N. Y.
H. J. Ruesch Machine Co., Newark, N. J.
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
W. A. Schuyler, New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Rahway, N. J.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Torrington Mfg. Co., The, Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Wire Rope
New England Butt Co., Providence, R. I.
Thomson-Judd Wire Machinery Co., Lynn, Mass.
Watson Machine Co., Paterson, N. J.

WHERE TO BUY, Continued

MACHINERY—Wire Tinning
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Rahway, N. J.

MACHINERY—Wood Screw
National Machinery Exchange (Used), New York, N. Y.

MACHINERY—Wrapping Wire
W. A. Schuyler, New York, N. Y.

MATERIAL HANDLING EQUIPMENT—
Cleveland Tramrail Div. of Cleveland Crane & Eng. Co., Cleveland, O.

MILLS—Tandem Rolling and Edging
Torrington Mfg. Co., The, Torrington. Conn.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

PANS—Vulcanizing
Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Insulating
E. W. Twitchell, Inc., Phila., Pa.

PATENT ATTORNEYS—
Lancaster, Allwine and Rommel, Washington, D. C.

PICKLING COMPOUNDS
American Chemical Paint Co., Ambler, Pa.

PIPING AND FITTINGS—Acid Resistant
Duriron Co., Inc., The, Dayton, O.
Haveg Corp., Newark, Del.

POTS—Lead Melting
Farrel-Birmingham Co., Ansonia, Conn.
John Robertson Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Farrel-Birmingham Co., Ansonia, Conn.
John Robertson Co., Brooklyn, N. Y.

PRESSES—Lead
John Robertson Co., Brooklyn, N. Y.

PULLERS—Wire
Scudder, E. J., Fdry. & Machine Co., Trenton, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.

PUMPS—Hydraulic
John Robertson Co., Brooklyn, N. Y.

PYROMETERS—
Leeds & Northrup Co., Philadelphia, Pa.

RECORDERS—
Leeds & Northrup Co., Philadelphia, Pa.

REEL AND TENSION STAND—
Fidelity Machine Co., Philadelphia, Pa.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., The, Torrington, Conn.

REEL CRUTCHES—
Watson Machine Co., Paterson, N. J.

REELS—Annealing and Stranding
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Steel
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Takeoff
Apco Mossberg Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

REELS AND SPOOLS—Shipping and Shop
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

REELS—Vulcanizing and Impregnating
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Chicago, Ill.

REFRACTORIES—High Temperature
Norton Co., Worcester, Mass.

ROD BAKERS—
Morrison Engineering Co., Cleveland, O.

RODS—Wire—Non-Ferrous
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Seymour Mfg. Co., Seymour, Conn.

RODS—Wire—Steel
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

ROLLS—
Farrel-Birmingham Co., Ansonia, Conn.

RUST PROOF COMPOUND—
American Lanolin Co., Lawrence, Mass.

SHEET—Steel
Continental Steel Corp., Kokomo, Ind.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

SKIN PROTECTOR—
Magnus Chemical Co., Garwood, N. J.

SOAPS—Industrial and Wire Drawing
Ironsides Co., The, Columbus, O.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Homer, N. Y.

SPOOLS—Annealing and Wire Drawing
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Chicago, Ill.

SPOOLS—Shipping and Shop
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Chicago, Ill.

SPOOLS—Steel
Apco Mossberg Corp., Attleboro, Mass.
Hayward, R . B. Co., Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Stevens Metal Products Co., Niles, O.

STAMPINGS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non Ferrous
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

STRIP—Steel
Continental Steel Corp., Kokomo, Ind.
Firth-Sterling Steel Co., McKeesport, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.

SWIFTS—Take-off
Apco Mossberg Corp., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.

TANKS—Compound
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Haveg Corp., Newark, Del.

TANKS—Steel
Mossberg Pressed Steel Corp., Attleboro, Mass.

TESTING INSTRUMENTS—
Scott, Henry L., Co., Providence, R. I.

TRAMRAIL SYSTEMS—
Cleveland Tramrail div. of Cleveland Crane and Engineering Co., Wickliffe, O.

TREADS—Safety
Norton Co., Worcester, Mass.

TRUCKS—
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

TUBE BENDERS AND FORMERS—
H. J. Ruesch Machine Co., Newark, N. J.

TURKS HEAD—
Standard Machinery Co., Providence, R. I.

VALVES AND FITTINGS—Acid Proof
Duriron Co., The, Dayton, O.
Haveg Corp., Newark, Del.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y. Co., Phila., Pa.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.

WIRE—Cold Heading
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Electric
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Enameled For Coils
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Nickel Silver and Phosphor Bronze
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.

WIRE—Non Ferrous to Specification For Special Purposes
Hudson Wire Co., Ossining, N. Y.
Seymour Mfg. Co., Seymour, Conn.
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Spring
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Seymour Mfg. Co., Seymour, Conn.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE—Steel—Also Coppered Steel——Also Galvanized Steel
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Pittsburgh Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, Ohio.

WIRE AND STRIP—Zinc
Metal Industry Works, Poland.
Platt Bros. & Co., The Waterbury, Conn.

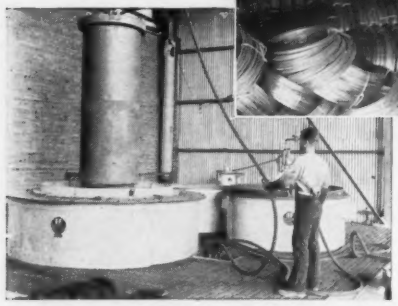
• Morgan-Connor Wire Machines save time, effort and valuable space through the unique features of their construction. They conserve time of threading dies by butt welding, and permit high drawing speeds on both high and low carbon stock. Heavy production schedules are maintained with a minimum of effort. Compact design effects considerable savings in floor space, and the need for special foundations is eliminated. Morgan Construction Co., Worcester, Mass., U. S. A.

MORGAN-CONNOR

Continuous Wire Drawing Machinery

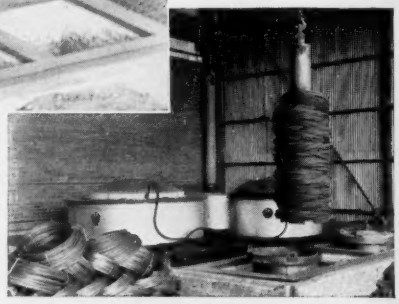
Sole European Representatives — Malmedie & Co., Dusseldorf, Germany

(Below) moving a sealed pot of wire from the pre-heater to the annealing furnace.



(Above) Showing charges in preheater, heating furnace and one of the cooling pits — The wire is in pots and is protected by Elfurno gas at all times — during heating and cooling. The Elfurno protective atmosphere generator is shown in background.

(Below) Removing a spindle of annealed wire from a pot in one of the cooling chambers.



Furnaces For Bright Annealing Wire

Strip, Tubing and Normalizing Rod

The above illustrations show a gas fired pit type furnace installation for bright annealing wire and normalizing and spheroidizing rod. This installation is also equipped with an Elfurno gas generator for controlling the surface condition of both rod and wire.

The number of repeat orders received from prominent wire plants substantiate our claim that "these pits turn out the most tonnage at the lowest cost with the most satisfactory surface condition obtainable and with the greatest flexibility of operation."

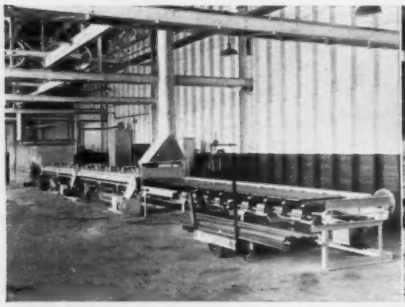
These furnaces are designed for firing with coke oven gas, mixed gases, natural gas or fuel oil and are furnished in single units or in batteries for any production.

Other outstanding installations we have made include various types of furnaces for bright annealing copper wire, steel or copper tubing, strip, stampings, clean annealing brass wire, scale-free hardening bolts, springs and miscellaneous other products as well as furnaces for nitriding, carburizing, copper brazing, billet heating, heating for forging and other heating and heat treating processes.

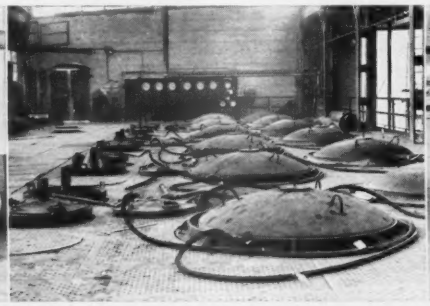
Write us regarding your furnace or heat treating problems.

The Electric Furnace Company, Salem, Ohio

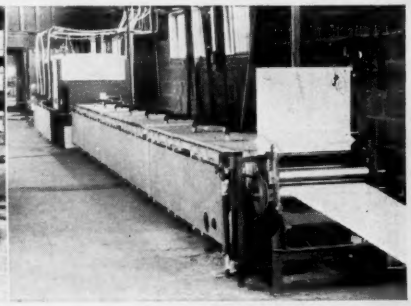
Gas Fired, Oil Fired and Electric Furnaces — For Any Process, Product or Production



BRIGHT ANNEALING STEEL TUBING. Various lengths and diameters are uniformly bright annealed—continuously—in this special atmosphere furnace and automatically unloaded onto trucks.



NORMALIZING AND SPHEROIDIZING ROD. Another "repeat order" — These pits also used for bright annealing wire. Bell or hood types also built for these processes.



BRIGHT ANNEALING STEEL STRIP. Continuous annealing advantages include quicker deliveries, shorter annealing time, absolute uniformity of finish and anneal.